THE AEROPLANE and ASTRONAUTICS

OCTOBER 30, 1959

EVERY FRIDAY
ONE SHILLING
AND SIXPENCE

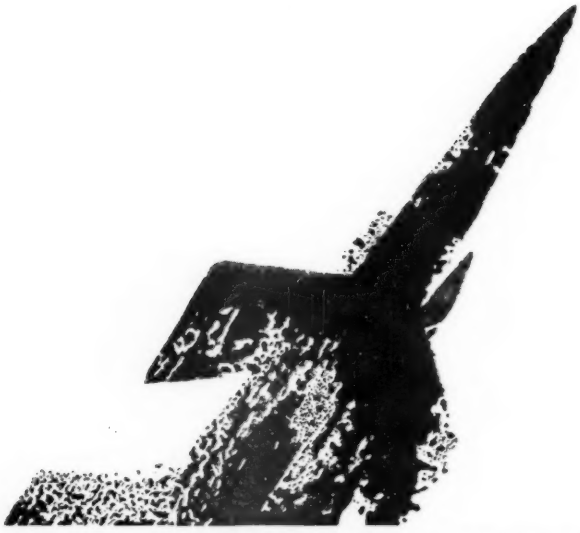
UNIVERSITY OF MICHIGAN
ENGINEERING LIBRARY

'ENGLISH ELECTRIC'
THUNDERBIRD

The only ground-to-air
Guided Missile system available for
both static and mobile use.

ENGLISH ELECTRIC AVIATION LTD
GUIDED WEAPONS DIVISION, LUTON · STEVENAGE · WOOMERA

A MEMBER OF THE ENGLISH ELECTRIC AVIATION GROUP



developments in flight equipment...

CONTROL UNDER 'g' The new approved Hymatic Anti-G valves AG5 and AG6, developed with R.A.E., improve upon the existing standard AG2 by using air tapped from the engine compressor. Weight, bulk and servicing time are thereby saved by eliminating storage bottles, ground charging valve and separate reducing valve and filter. High or low gradient protection up to 8 g can be selected to suit personal comfort. The AG5 weighs 1.9 lb. for supply pressures up to 150 p.s.i. The AG6 weighs 2.2 lb. for supply pressures up to 300 p.s.i.

Hymatic, as leading engineers in the Aircraft equipment field, have been responsible for the design and precision manufacturing of many products, including:

Hot air reducing valves
Snap jacks and air bottles
Oil reducing valves
High pressure relief valves
Restrictor valves
Pressure maintaining valves
High flow reducing valves
Non-return valves

...by Hymatic

194

THE HYMATIC ENGINEERING COMPANY LIMITED · REDDITCH · WORCESTERSHIRE

THE AEROPLANE and ASTRONAUTICS

VOLUME 97 NUMBER 2506 OCTOBER 30, 1959

The Air Fares Breakdown

People seem to regard the failure of the IATA traffic conferences in two ways. One is to praise B.O.A.C. (or the now defunct M.T.C.A. and its Minister) for standing out so uncompromisingly for a lower basic fare-structure and to believe that this stand will eventually produce results—or, at least, cause IATA to look very critically at its fare-controlling machinery. The other is to accept this machinery for its democratic virtues and to blame B.O.A.C., and its Government advisers, for retaining its membership of IATA whilst refusing to play the game according to the Association's rules.

Can it be that the essential reason for the failure was not the unanimity rule for the conferences, or even the considered intransigence of one airline—but the fundamental fault in the way of thinking of airlines and governments during the past decade? Because of the difficulties of international and inter-airline fare agreement, the natural competitive urge has been channelled into the provision, at very great capital expense, of better and faster aircraft equipment. In consequence, airline-fare conference battles have been concerned, to an almost ludicrous extent, with agreed ways and means by which the passengers should be ever more tightly packed in the available space.

Maybe a period of open-rate "chaos" will give airlines a chance to think about some realities of air transport business.

Manpowairg Meets

Tonight, October 30, is to see the holding of the first meeting of the Man-powered Aircraft Group of the Royal Aeronautical Society, at 4 Hamilton Place, London, W.1. The president, Mr. Peter Masefield, will take the chair at 7 p.m. It is nearly three years since MAPAC held its inaugural meeting at Cranfield and since then much has happened. Two prototypes have been completed and each has been tested on an airfield. Both have yet to leave the ground under muscular power alone.

In this issue we outline the design of each. Here it is enough to say that it is eminently satisfactory that on the eve of the first meeting of the new R.Ae.S. Group one prototype should be an ornithopter and the other should rely on the well-proved propeller. A further encouraging sign is that each has been built by individual effort.

Neither Mr. Hartman nor Mr. Perkins has any doubt of the size and difficulties of the problem each has set out to resolve. Mr. Hartman, since the weight of his machine, fully loaded must be around 450 lb., intends to start with aero-towing. Mr. Perkins will achieve the first stage of his ambition when he can pedal his machine off the ground in straight and level flight for a hundred yards or so.

Real progress will have been made when "Manpowairg," if we may so abbreviate the title of the new group, gets busy on organizing the first man-powered aircraft competition, with a substantial prize for the first contestant to complete a circular course of, shall we say, a mile, having taken off by the sole aid of the muscles of the crew on board the craft.

Editor - - - - THURSTAN JAMES
Deputy Editor - - - - F. T. MEACOCK

Founder Editor (1911-1939) *C. G. Grey*

Proprietors: TEMPLE PRESS LIMITED
Chairman and Managing Director:
ROLAND E. DANGERFIELD

Editorial, Advertisement and Publishing Offices:
BOWLING GREEN LANE, LONDON, E.C.1.

Telephone: TERminus 3636
Telegrams: "Pressimus London Telex"
Telex: 23839

Annual Subscription Rate: United Kingdom £4 15 0
Overseas £5. Canada and U.S.A. $15.00

© Temple Press Limited, 1959. The proprietors will consider any written requests to reproduce articles and illustrations appearing in this journal. Comment and brief extracts which acknowledge *The Aeroplane and Astronautics* are permissible.

Matters of Moment

Prince Philip on Air Matters

FOR the past half-century the Air League of the British Empire has acted as a sort of watch-dog for British air power and, over the years, has constantly urged developments and reforms which it felt were needed for the continuing growth and increasing strength of British aviation generally. Last week this enterprising organization had its Jubilee luncheon—at the Mansion House—at which its Patron, H.R.H. Prince Philip, Duke of Edinburgh, presided.

This was one of those happy occasions on which a very large and distinguished gathering represented all aspects of aeronautical industry and civil and Service aviation. And it was abundantly clear that, as the League's Royal Patron observed, this fiftieth anniversary was being celebrated with a sense of satisfaction with past achievements and a sense of pleasant anticipation about the future.

In his address His Royal Highness referred to a number of matters of particular interest to the Air League's members. Among them, for example, he spoke of the recent appointment of a special Minister for Aviation and said that the Air League was delighted with that development.

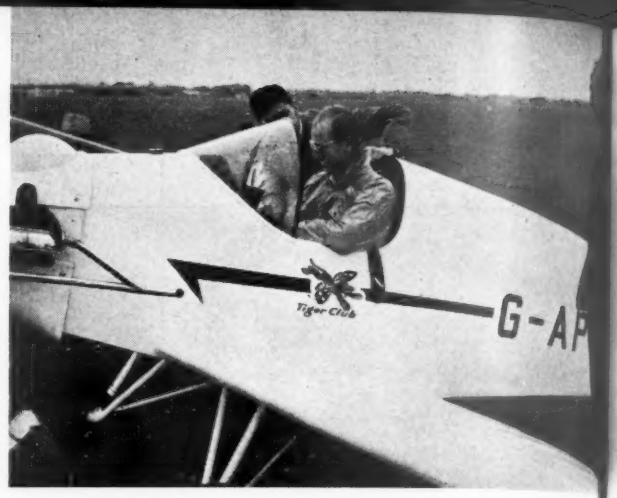
Another matter that had given members much pleasure recently was the news that B.E.A. was to make substantial fare reductions next summer. On the other hand, they were highly disappointed with IATA which had "obstinately refused to recognize the force of the League's arguments for cheaper fares on World routes."

His Royal Highness also drew attention to the increasingly rugged competition coming from America's aircraft industry.

After a brief reference to Service aviation, the Duke had something to say about private flying. The Air League very much hoped, he said, that modern engineering ingenuity would make it possible for many more people to enjoy flying . . . "with all the gentle grace of a small aeroplane over the pleasant countryside of these Islands and the Continent."

Saturn Joins NASA

AFTER weeks of uncertainty over the fate of the Saturn booster and Dr. Wernher von Braun's group of ex-German scientists at the Army Ballistic Missile Agency, at Huntsville, President Eisenhower has now decreed that, subject to the approval of Congress, the entire project will be placed under the ægis of the National Aeronautics and Space Administration.



LIGHTWEIGHT COUNSEL.—Before taking off for his recent flight in the Rollason Turbulent, Prince Philip is briefed by his equerry, Sqn. Ldr. John Severne (left) and Mr. Norman Jones, chairman of the Tiger Club.

This decision followed a meeting on October 21 to which the President had summoned among others Mr. McElroy, the Secretary of Defense, Mr. Glennan, administrator of NASA, Dr. York, director of research and engineering, Department of Defense, and budgetary advisers. Less than a month ago, it was resolved that henceforth all space-vehicle boosters would be the concern of the U.S.A.F., but the latest announcement now states that the development of "super booster special vehicles" will be vested in NASA.

Clearly, the renewal of interest in Saturn (and the von Braun group) has been influenced by the recent spectacular Russian success with Moon probes, which has stepped up the clamour for more energetic boosters. Saturn's clustered engines have a potential thrust of up to 1.5 million lb.

However, as things stand, the current NASA budget is inadequate for Saturn's development and Congress will have to approve additional funds. Only recently, the budget for Saturn was cut from $135 million to $70 million to satisfy Defense Department criticisms that the giant booster was an expensive luxury with little immediate military value. The project had been supported by ARPA on the grounds that it would provide a means of launching large communication satellites on 24-hr. orbits.

Now, in the hands of the "civilian" Space Agency, the big booster may have an important future in space research in direct competition with its contemporaries beyond the Urals.

Secretary of the Royal Aeronautical Society since 1951, *Archibald Morton Ballantyne, T.D., Ph.D., B.Sc.(Eng)., A.M.I.C.E., F.R.Ae.S., A.M.I. Struct.E., A.R.I.C.S., A.F.I.A.S., Hon. F.C.A.I., has watched over its steadily expanding fortunes and has every reason to be pleased with the record membership figure of* 10,000, *now likely to be surpassed as a result of the recent merger with the Helicopter Association of Gt. Britain. This photograph was taken after he had inspected the first stage in the Society's latest expansion programme, the building of a lecture hall in the former garden of the Society's premises to hold* 300 *people. The Council of the Society recently voted to go ahead with the* £150,000 *scheme in order to take advantage of the new roadbuilding work at Hyde Park Corner.*

Photograph copyright "The Aeroplane and Astronautics"

A Royal Ultra-light Solo

AFTER several years' experience of flying de Havilland Herons and Westland Whirlwind helicopters of the Queen's Flight, H.R.H. The Duke of Edinburgh made his first venture into ultra-light aviation on Saturday, October 24, when he flew a Rollason-built Turbulent at White Waltham. During the 35 minutes that Prince Philip flew the single-seat Turbulent, in gusty weather conditions, he completed five landings, and expressed very great enjoyment on his return.

The Turbulent, G-APNZ, was the aircraft entered by the Duke in this year's National Air Races, and flown by his aide, Sqn. Ldr. John Severne, A.F.C. It is a Tiger Club aircraft, and the pre-flight briefing on its handling was undertaken by the chairman of the club, Mr. Norman Jones.

Prior to his Turbulent flight, Prince Philip had a brief refresher trip in a London University Air Squadron Chipmunk, with Flt. Lt. Tony Winship. The Duke had completed 13 hr. solo on Chipmunks during his initial training at White Waltham, followed by 22 hr. solo on Harvards, but had not flown any similar aircraft since 1953. The Turbulent was also his first experience with an open-cockpit aircraft.

During his visit to White Waltham, Prince Philip also inspected two other ultra-light types. These were the Tipsy Nipper, OO-NIP, which had been flown over specially from Belgium for the occasion by M. Bernard Neefs of Avions Fairey, and the home-designed and built Taylor monoplane. The Nipper was the first of its type to have dual ignition on its Volkswagen engine, and a 20-channel VHF radio weighing only 15 lb.

The Minister for Science

LORD HAILSHAM, Lord Privy Seal and Britain's first Minister for Science, gave a Press conference in London on October 21. At it he discussed, among other scientific matters, the question of space research.

"In some ways," he said, "the focus of scientific opinion in this country is the Royal Society. Long may it flourish. But for the purpose of advising the Government on scientific policy, the proper channel already exists in the form of the Advisory Council on Scientific Policy.

"I believe that this body provides one of the keys to the present situation, composed as it is of a unique connection of Government and non-Government scientists under an independent Chairman with a Vice-Chairman who happens also to be the Chairman of the Defence Research Policy Committee. I shall endeavour to rely more than ever upon the A.C.S.P. for generalized advice on questions of scientific policy. . . .

"One of the matters I referred to the A.C.S.P. in the last Parliament was the question of space research, and it was as a result of their advice that the Steering Group under Sir Edward Bullard was set up and the group of scientists under Professor Massey paid their recent and successful visit to America."

For the rest, Lord Hailsham was at pains to point out that his appointment and its general influence on scientific progress in this country should be viewed in the long term. "You must not expect clutches of satellites to be flung into orbit in a miraculously short space of time. Sponsors of ingenious inventions will be disappointed.

"The Minister is not a repository of brilliant new thoughts which have failed to appeal to anyone else. He is not overlord to the Minister of Education and will not therefore be able to create vast new academies of science and technology. He is not Master of the Queen's Rockets and will not therefore play a decisive part in the politics of guided missiles. . . ."

In defining his terms of reference, the Lord Privy Seal said that science touched life at every point, and industry, agriculture, medicine, teaching, the universities, and Government were its indispensable partners. "In all these spheres, my task is to promote science. But only in part of one of these spheres of activity—that of Government—have I the power to achieve this by the use of authority as distinct from encouragement, diplomacy, enthusiasm, example, precept or advice. . . . My hope will be to engender in all a genuine enthusiasm for science."

AERONAUTICAL DELEGATES.—Members of the R.Ae.S. and I.A.S. were shown something of America's missiles and space vehicles during the recent Anglo-American Conference. Among the delegates in these views can be seen W. Tye (A.R.B.); H. H. Gardner (Vickers-Armstrongs); E. D. Keen (A.W.A.); C. Dykes; P. G. Masefield (Bristol Aircraft), President R.Ae.S.; Prof. A. R. Collar (Bristol University); H. G. Conway (Short); D. Keith-Lucas (Short); Mrs. J. Bradbrooke (R.Ae.S.); J. B. Edwards (Handley Page).

Re-entry Survey

MR. T. R. F. NONWEILER'S lecture to the R.Ae.S. Astronautics and Guided Flight Section on October 22 about atmospheric re-entry marked his "abdication" as far as this subject was concerned, he said. Speakers in the discussion hoped he was not serious about his abdication in a subject on which he has been an authority for years.

His lecture broke with custom; there were no slides, illustrations or formulæ. Instead Mr. Nonweiler gave a lucid survey of the many difficulties involved in re-entry calculations and went on to discuss the radiation and ablation approaches to re-entry shielding and their application to missiles, satellites and spacecraft.

He emphasised the formidable navigation problems of manned re-entry; the Earth's atmosphere had been compared in thickness with the cellophane cover round a new golf-ball. For re-entry of a non-lifting vehicle the perigee had to be within a height band only 7 miles deep if the maximum deceleration was to be restricted to 10 *g*.

One point Mr. Nonweiler made was that no effective measure of speed was yet used for space vehicles. He suggested that their speed should be related to orbital or "circling" speed to give a non-dimensional value analogous to Mach number. In a delicate tribute to the lecturer one member of the audience suggested that this should be known as the N number.

Man-powered Aircraft Prototypes

By B. S. Shenstone

IT is heartening to know that there are still people willing to spend time and their own money to turn their ideas into hardware. Almost simultaneously two very different possible solutions to the man-powered flight problem have appeared and are about to be flight tested. Both have been under way and under wraps for some time. The *Daily Mail* has publicized E.n.el Hart.nan s ornithopter, and now the *Daily Express* has done the same thing for Dan Perkins' inflated wing propeller-driven machine.

Both these machines have interesting features which are worth describing and thinking about even if (but perish the thought!) they don't work first time.

Hartman, who is a sculptor by profession, has had a flapping-wing sche.ne in his head for years and has made several quite flyable flapping models to demonstrate some of his ideas. The basic idea behind his present prototype is the use of a spring-balanced wing operated at its natural frequency by leg and arm power.

The flapping wings are on straight hinges at the roots and are held down to the normal level position for non-flapping flight by springs. These springs are so proportioned that the natural frequency of the system is such that it can be kept in flapping motion at a speed convenient for arms and legs. Hartman's claim is that since such a system is easy to move, it will be easy to fly.

The present writer witnessed a mock-up of the scheme in Hartman's studio. In a frame were suspended two weights each of the order of 300 lb. These weights, representing the wings to be moved including any resistance of the air to flapping motion, were suspended in a neutral position by springs. The operator sat in the equivalent of a rower's seat and by leg motions (arms might also be used) the weights were raised and lowered at the natural frequency of the system.

Hartman found that he could easily raise these weights a foot every second for an hour or more continuously. This, he claims, is equivalent to expending or producing one horse-power. A horsepower is defined as 550 foot-pounds per second. Actually the driver does not himself expend one horsepower for this period, as that is well known to be physically impossible, but it is claimed that if the weights are shifted as described, one horsepower comes out somewhere.

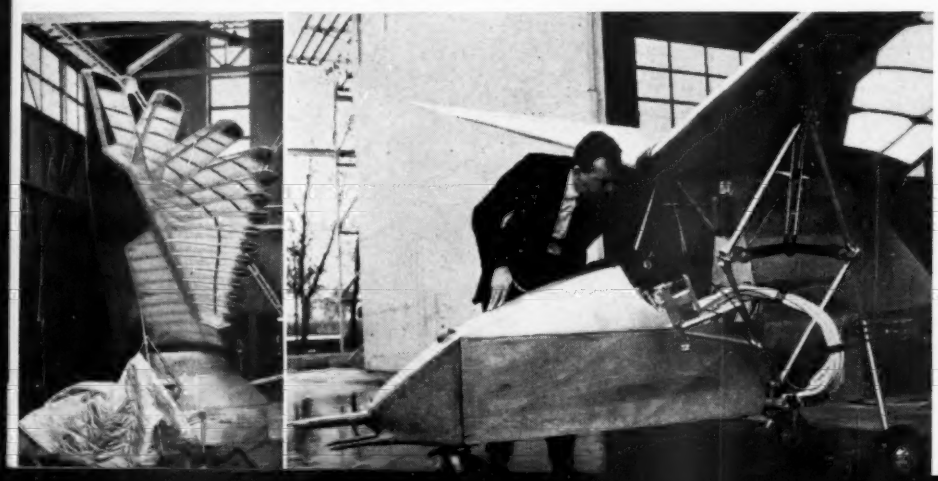
Hartman has had technical assistance in designing and stressing his ornithopter which is characterized by the use of pinions on the trailing edge and tips of his wing. During flapping these pinions move in such a manner as to give the same effect as varying the wing incidence. It is known that simply flapping a stiff wing on a straight hinge is not much help, because the wing incidence should increase during the upstroke and decrease during the downstroke.

The use of wing-tip pinions is also to be seen on the German flapping wing aircraft designed by Filter and shown in Hannover in 1958. No information is available on the method of flapping used by Filter.

Hartman's machine of 36 feet span is of typical sailplane construction in wood and fabric with normal tail surfaces and has a fixed tricycle undercarriage with steerable and braked nosewheel. To allow space for the flapping mechanism the wing is placed relatively high, considering the low fuselage, but even so it is only about 4½ feet above the ground at the root, and the tips when drooped about 18 inches.

The single-spar wooden wing is hinged at the spar and at the end of the normal sailplane type of root diagonal rib. It is in effect a braced wing, the bracing being a bundle of heavy bungees taking the place of struts, or rather of flying wires. There is a stop cable to limit the bungee stretch and upward flapping angle.

Since the wings when unloaded on the ground would normally droop, a toggle scheme has been introduced to enable



Above, the Hartman man-powered ornithopter built by Dan Campbell of Hungerford. It weighs 282 lb. empty. Wing area is 144 sq. ft. Left, the pinioned wings are pulled down by wires and pulled up by closing these toggle-struts.

the wings to lie more or less horizontal under such conditions. This is seen as a diamond-shaped frame between the wing lower surface (fairly close inboard) and the sides of the fuselage at the bottom. The free angles of the diamonds are joined by bungees so proportioned that the unloaded wing is kept at the position desired. There is also a check wire to prevent the wings going too far down.

The pilot uses his arms and legs to fly, but the legs do most of the work. Bracing his back against the wing pylon, both feet are pushed forward either together or if the pilot desires they can be operated independently. The resultant thrust pulls cables which pass outside the fuselage and up to the wing immediately outboard of the point where the toggle picks up the wing. Thus the wings are flapped downward.

The pilot's hands are holding handles on each side of and just outside the cockpit which by twisting and rocking operate the controls which are limited to elevators and rudder. There are no ailerons or wing-warping. The trailing elevator tabs are for aerodynamic balance, necessitated by the small control leverage available because of the controls used.

But the pilot does not only control the aircraft with his hands, but as his feet press forward to flap the wings down, the hands are also pressed forward and spread the toggle diamond. In this way they assist the wing motion. When the feet are eased back to permit the wing to flap upwards, the handgrips are pulled back, thus reducing the tension in the cross bungee in the toggles and permitting the wing to flap upward beyond the middle position.

It will be noted that this is, as far as the relation between arm and leg motion is concerned, the opposite of rowing.

It is not Hartman's intention to take off at present under his own power, but to be towed off by motorcar and save his energy for level flight. In any event with the present undercarriage the craft cannot be given sufficient nose down attitude for the best take-off results.

Above, Alan Lock (left) helps Dan Perkins (right) into their propeller-driven man-powered inflated wing machine (below) which has a span of 40 ft. and wing area of 100 sq. ft. It weighs 74 lb. without the pilot.

Photographs copyright "The Aeroplane and Astronautics"

Perkins, who has specialized on inflated wing aircraft construction and development work, has now designed and built with only one assistant, Alan Lock, a beautiful slim 40-ft.-span wing of 100 sq. ft. area out of inflated tubes faired into a well-shaped section. There are a series of span-wise tubes which when inflated put tension into a smooth continuous outer skin and cleverly pushes sticks out into the trailing edge at rib intervals. The result is, surprisingly enough, a normal wing shape. Since such an inflated shape has very little bending resistance it must be braced by a number of flying wires. However, an inflated wing of this kind is said to have quite good torsional stiffness.

The fuselage of Perkins' machine is a totally enclosed pod slung below the wing, the entrance to which is underneath as on the Avro Vulcan, but the scale of this machine makes the act of entering less graceful. The pilot sits like a cyclist and works only his legs on bicycle pedals. A rubber-covered rope belt leads from the pedal pulley aft and around pulleys below the wing trailing edge and then upwards to a pulley on the propeller shaft. The system includes an automatic belt-tensioner.

The single propeller is a 9 ft. 8 in. variable-pitch pusher of unique design. The blades are light fabric-covered frames fitted in spigots on the hub. The blades are located on the spigots by bolts in curved slots and the blades are connected to each other across the propeller shaft by several coil springs. As the propeller speed is increased, centrifugal force forces the blades outward against the springs and because of the curved slots the blade incidence is increased. Work is also being done on a twin-screw arrangement.

The tail end of the aircraft is a simple open network of piano wires and struts, but mainly piano wires. These hold aloft a small rudder. There is no horizontal surface. It is planned to achieve longitudinal control by changing the wing incidence with respect to the fuselage. The incidence is controlled by twin grips on the handle-bars. There is no lateral control.

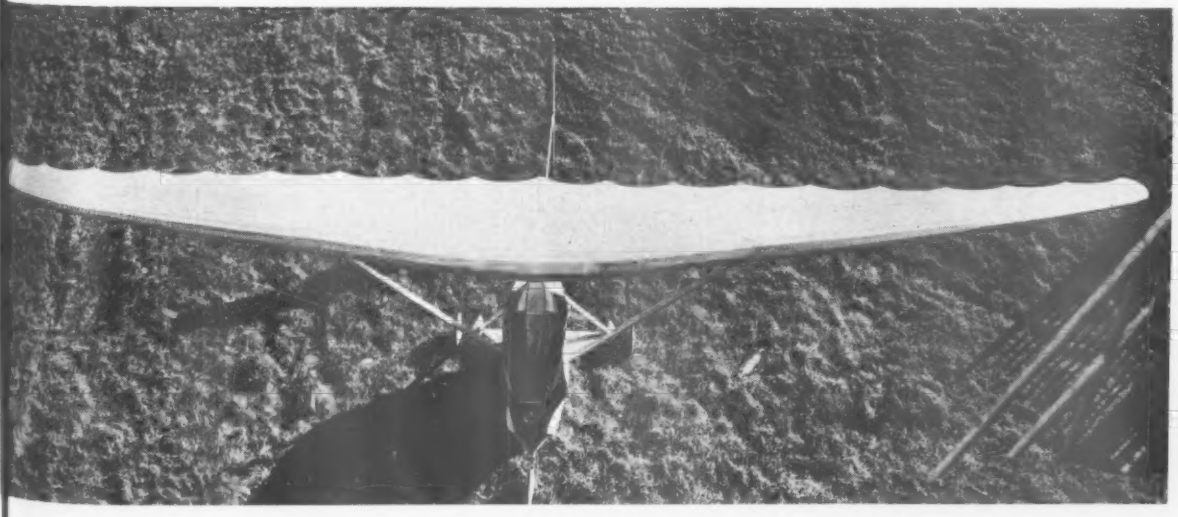
The undercarriage is tricycle, using small light pram-like wheels.

Perkins has made a number of ground runs up to about 20 m.p.h. but so far he has not flown although he has almost unstuck.

The detail design of Perkins' machine is in many respects brilliant. All the details are well worked out, often in a far from usual fashion, and he uses a number of quick-detachable fittings of simple and unexpected form. The weights are very low, the whole aircraft less crew weighing only 74 lb. and with Perkins himself it grosses only about 200 lb.

The lack of tailplane and ailerons, as fully appreciated by Perkins, may lead to difficulties and he is prepared to improve his controls and stability as required by his experience. However, he is anxious to get off the ground even if initially he does not have all the control he could wish for.

It is apparent that both Hartman and Perkins intend to try out their vehicles most carefully, so we are not likely to hear of anything spectacular in the near future, and certainly not of spectacular accidents. Here we have careful and quiet men, both with unshakable ideas and determined to show that their ideas are good ones.



General Aviation News

LATEST PIPER.—Developed from the Apache light twin, the Piper Aztec is a five-seater with two 250 b.h.p. Lycoming engines and a cruising speed of more than 200 m.p.h. Its gross weight is 4,800 lb. and useful load, 2,025 lb. U.S. cost is $49,500.

COMET TO COLOGNE.—A de Havilland Comet 4B was demonstrated in Cologne on October 19, to Lufthansa, the German Ministry of Defence and other interested parties. Preliminary talks have been held between de Havilland and Lufthansa on the possible sale of Comets to the German airline.

SPUTNIK SIGNALS.—Launched on May 15, 1958, Sputnik III is still broadcasting signals. Its solar batteries have now operated for more than 8,000 hr., an average of 18 hr. per day. The chemical batteries, which power the radios when the satellite is in the Earth's shadow, have operated for about 2,600 hr.

SATELLITE SILENCE.—The radio transmitters aboard Explorer VI, the so-called "paddle-wheel" satellite launched on August 7, have unaccountably lapsed into silence. Fitted with solar batteries, the vehicle was performing 15 concurrent experiments, including studies of the behaviour of radio waves in the ionosphere, the nature and extent of the Earth's magnetic field, and micrometeors. It was also checking equipment for use in a future Venus probe. The transmitters were triggered by command signals from Earth.

DYNA-SOAR.—First-phase development work on the U.S.A.F.'s Dyna-Soar project for a manned re-entry glide vehicle were completed this summer by Boeing and Martin. The work done by both companies is now being evaluated by the Air Force, but as yet no final contract has been awarded.

MORE PROBES?—"At the present time, one of the problems facing science is that of maintaining radio communication with rockets which may be sent to Mars and Venus," Alexander Nesmeyanov, president of the U.S.S.R. Academy of Sciences, told a meeting of the Young Communist League in Moscow on October 21.

MAN - POWERED FLIGHT.—The inaugural meeting of the R.Ae.S. Man-powered Aircraft Group will be at 4 Hamilton Place, W.1, at 7.00 p.m. tonight, and not 7.30 p.m. as reported last week.

R.A.F. THOR.—Seven Thor IRBMs have now been launched by R.A.F. crews from Vandenberg AFB in California. The most recent firing was on October 22.

NAVIGATION AWARDS.—At the annual general meeting of the Institute of Navigation on October 22, H.R.H. the Duke of Edinburgh presented the Gold Medal for 1959 to Mr. J. E. Clegg, for his work on the development of Doppler navigation. The Duke also presented a certificate to Sir Robert Watson-Watt, who has been elected an Honorary Member of the Institute.

GERMAN C-130s? — Production experts from Hamburger Flugzeugbau, Weser Flugzeugbau and Focke-Wulf are visiting Lockheed's Georgia Division to discuss possible manufacture of Hercules transports under licence in Germany. Interest is centred on the STOL version of the Hercules.

SAUNDERS-ROE ROTORCYCLE.—First flight of a Hiller XROE-1 Rotorcycle built by Saunders-Roe was made on October 19 from Southampton Airport, Eastleigh. The pilot was Mr. Phil Johnston, head of the flight department of the Hiller Aircraft Corporation, California. Saunders-Roe announced in November, 1958, that they had made an agreement with Helicop-Air, Paris, the Hiller European agents, to build a number of these one-man helicopters.

MIRAGE BOMBER PLANS.—Although original plans for scaling-up the Dassault Mirage IV supersonic bomber to carry the French nuclear weapon have been abandoned, the design is to be developed in a smaller and more economical form. Instead of two Pratt & Whitney J75s, the Mirage bomber will be powered by two Snecma Atar 9J engines, each developing 16,534 lb. with afterburning. A contract was signed on September 18 for a prototype and small pre-production batch of aircraft.

P.S. TO M.o.A.—Mr. A. G. F. Rippon has been appointed Parliamentary Secretary to the new Ministry of Aviation. Previously he was Parliamentary Private Secretary to the Minister of Defence.

DIVISIONAL MANAGER. — Mr. P. A. Hearne, D.C.Ae., D.L.C., A.F.R.Ae.S., has joined Elliott Bros., Ltd., as Divisional Manager of the Guided Weapons Division. Mr. Hearne was formerly Sales Manager of the aircraft equipment group of the British Oxygen Company.

DOWTY DIRECTOR.—Mr. J. C. G. Wegerif has been appointed a director of the Dowty Group, Ltd., to advise on production policy; during the War he was production director of Dowty Equipment, Ltd. He will not be a full-time director; the Bentley Engineering Group has agreed to allow him to devote some of his time to Dowty production policy.

FLT. LT. D. A. S. McKAY.—We regret to record the death of Flt. Lt. D. A. S. McKay, D.F.M. and Bar, who served with No. 43 (F) Squadron in France and during the Battle of Britain. He was officially credited with destroying 16½ enemy aircraft. Subsequently he flew in North Africa, and as an instructor from 1944 to 1955. He contributed a number of flight assessment articles to THE AEROPLANE in the immediate post-War years, and since 1948 has energetically supported Air Britain, the organization for aviation enthusiasts.

BELFAST VISIT. — Air Vice-Marshal G. P. Chamberlain (second from left) deputy controller of electronics, and Mr. J. G. Brown (centre), assistant director, guided weapons production, with Mr. R. E. Harvey (extreme left), Mr. K. Teale and Mr. J. Dent of Shorts.

Air Transport

B.O.A.C. Battles On

WITH a total deficit, after paying interest on capital, of £5,179,420 in 1958-59, B.O.A.C. had its worst year since 1949-50, when the deficit was nearly £8 million. It was the eighth year since the end of the War in which the Corporation has suffered a final deficit.

The B.O.A.C. Annual Report and Accounts for the year ended March 31, 1959, published at the end of last week, are naturally much concerned with putting this poor result in perspective, as also was the chairman, Sir Gerard D'Erlanger, at the press conference held to introduce the report. The most encouraging things Sir Gerard had to say, however, concerned results in the present (1959-60) year, in which there is some reason to believe that the result for B.O.A.C. and its Associated Companies will at least break even after payment of interest.

In the first six months of this year, starting on April 1, passenger revenue showed an increase of 15% over the same period of 1958-59, whilst on the Atlantic route the increase was 35%, with a doubling of the net dollar earnings on this route. In this six-month period, a surplus of about £1,100,000 has been achieved by B.O.A.C. alone (after payment of interest) whereas a loss of about £150,000 was recorded at the same time last year. The results of the Associated Companies also show an improvement of about £1¼ million compared with last year, although these results are not yet out of the red.

Operating costs are going down. By the end of 1959 they should be of the order of 35d. per capacity ton-mile, with a further reduction to a figure as low as 30d. by the end of 1960. Engineering costs are similarly coming down, from 10½d. per c.t.m. in 1957-58 and 9d. in 1958-59, to 7d. in 1959-60 and, it is hoped, 5½d. in 1960-61. Capacity ton-miles offered are expected by 1960-61 to be more than double the 1957-58 total, while on the Western routes alone they will be four times the 1957-58 figure by 1963-64.

Reasons for the Losses

Significant operating and financial results are tabulated, right, and comparative statistics for the past 10 years appear below. Points of note are that B.O.A.C.'s own results yielded a profit of £843,123 before providing for interest, and that interest on capital increased by about £1 million compared with the previous year, because of increased investment in new equipment. Well over half of the total deficit was attributable to the operations of the Associated Companies, including an operating loss of £2,532,207. The combined result of B.O.A.C. and its Associated companies was made up of an operating loss of £1,689,084, and interest on capital of £3,490,336.

Total traffic revenue increased, during 1958-59, by 9.1%, compared with a major-airline World average of 5%.

Adverse factors affecting the overall results included the continuance, for several months in 1958, of the World-wide business recession; the strike of engineers in October, 1958, which is estimated to have cost the Corporation not less than £1,250,000; the continuing expense of introducing new aircraft types, which was particularly heavy in the 1958-59 year; a net capital loss on the disposal of aircraft and other assets; and the abnormal losses of some of the Associated Companies.

The accounts show a charge of £1,123,069 as the net capital loss on disposal of piston-engined aircraft. This loss is a direct sequel, says the report, of the withdrawal of the Comet 1s from service in 1954, which forced B.O.A.C. to buy second-hand aircraft at inflated prices.

The report points out—once again—that B.O.A.C. bears a charge for interest on the whole of its capital, whereas many airlines have a large proportion of equity capital which does not attract a dividend unless a profit is made. Another charge which the Corporation feels it should not have to bear is that of introducing new types of British aircraft into service. By spending over £150 million on Britannias, Comet 4s, Viscounts and V.C.10s, B.O.A.C. has spent more on British aircraft than any other airline in the World, and it feels that the additional expenses of introducing an aircraft into service should be paid by the Government. A sum of £5 million has been written off by B.O.A.C. in respect of abnormal development costs of the Britannia and Comet.

A special re-appraisal is being made by B.O.A.C. of each of the various Associated Companies, to judge whether its current and future value is commensurate with its likely future prospects. The status and results of the various associated companies are discussed in detail in the Report.

Fares Policy

The report naturally (by virtue of its time-span) has nothing to say of B.O.A.C.'s recent battle at the IATA Traffic Conferences, where the Corporation's determination to maintain a three-tier fare structure on the Atlantic and to introduce

THE FINANCIAL RESULTS IN BRIEF

	1958/59	1957/58
Corporation's Operations	£	£
Total revenue	58,401,855	53,526,375
Net expenditure (excluding interest on capital)	57,558,732	53,854,277
Profit	843,123	327,902
Interest on capital	2,927,774	(loss) 1,920,700
Loss after remuneration of capital	2,084,651	2,248,602
Associated Companies Operations		
Loss	2,532,207	439,228
Interest on capital	562,562	151,520
Loss after remuneration of capital	3,094,769	590,748
Total loss	5,179,420	2,839,350
Percentage increase in capacity produced by B.O.A.C. over previous year	24.1%	18.6%
Cost per unit of output	36.2d.	38.7d.
Percentage increase in traffic revenue over previous year	9.1%	9.2%
Average overall load factor	57.0%	60.5%
Average passenger load factor	60.4%	63.3%

Capital

At March 31, 1959, the total borrowings of the Corporation amounted to £132,910,820 made up as follows:

	£
British Overseas Airways Stock	58,425,106
Exchequer Advances	65,314,286
Bank Loans	9,171,428
	132,910,820

which is represented by:	£	1958/59	1957/58
Capital employed:			
On Corporation's current operations	79,952,956	60.1%	59.0%
In Associated and Subsidiary Companies	12,624,184	9.5%	10.9%
Progress payments for future aircraft	27,371,097	20.6%	30.1%
	119,948,237	90.2%	100.0%
Accumulated deficit on past operations	12,962,583	9.8%	
	132,910,820	100.0%	

A DECADE OF B.O.A.C. RESULTS

	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59
Capacity ton-miles flown (×1,000)	133,773	158,500	190,722	208,107	220,530	214,924	260,286	282,135	329,735	376,733
Load ton-miles sold (×1,000)	70,422	92,348	120,294	129,429	136,068	133,343	155,758	175,176	189,645	201,500
Revenue load factor %	55.5	59.7	65.7	64.5	64.5	63.7	61.7	63.7	60.5	57.0
Revenue passengers carried	155,557	200,514	250,173	290,629	304,980	291,136	385,778	409,684	480,344	495,170
Passenger load factor %	60.7	56.4	63.9	63.6	63.5	61.6	62.2	66.0	63.3	60.4
Freight carried, tons	4,429	5,598	6,807	6,583	6,276	6,756	7,979	8,407	8,957	8,778
Mail carried, tons	2,003	2,272	2,895	3,110	3,366	3,407	3,815	4,145	4,103	4,064
Total revenue per c.t.m., d.	33.1	35.6	41.3	41.1	41.4	40.9	39.1	41.3	38.6	36.9
Operating costs per c.t.m., d.	44.9	40.6	39.5	41.1	39.1	39.6	37.8	39.6	38.7	36.2
Passenger revenue per pass. mile, d.	5.7	6.0	6.0	6.4	6.4	6.3	6.3	6.5	6.4	6.5
Operating revenue, £ (×1,000)	18,431	23,529	32,831	35,699	38,077	36,610	42,428	48,587	53,031	57,588
Profit or loss on operating account, £	−6,571,911	−3,311,956	+1,403,061	+10,161	+2,157,791	+1,139,100	+1,441,602	+2,062,492	−165,551	+996,112
Surplus or deficit after remuneration of capital, £	−7,791,887	−4,565,428	+274,999	−838,664	+1,065,397	+261,687	+117,731	+303,352	−2,839,350	−5,179,420

Air Transport . . . .

economy-class fares elsewhere has threatened to produce an open-rate situation after April 1, 1960. In view of the unprecedentedly "tough" line which B.O.A.C. is now taking, however, some statements in the Report are worth quotation; and particularly this:—

"B.O.A.C. has always been in the vanguard of movements to cheapen fares, but it believes that the international fare levels agreed between the World's airlines must be the basis of well ordered competition. To leave each airline free to set its own fares would be a retrograde step, as past experience in this and other transport industries has shown."

Or, again, when discussing the introduction of a jet surcharge on the Atlantic, the report says "the proponents of the jet fare supplement were prepared to press their point to the length of creating an open-rate situation in which all operators would be free to set their own fares. Without agreement on rates, interline arrangements between carriers, which have become an established feature of the international air transport industry and which provide great advantages to the individual air traveller, would not be possible."

This reads a little strangely today, but Sir Gerard maintains that B.O.A.C. has no intention of leaving IATA, nor of breaking it. Nevertheless, with no agreement on economy-class fares within IATA, B.O.A.C. is expected to press the Government once again, through the new Minister of Aviation, for permission to reduce fares by about 20% on the cabotage routes to East and Central Africa, the Caribbean and possibly Hong Kong via Singapore. (In fact, Government permission does not have to be obtained to comply with the Act, but, says Sir Gerard, it has been a custom to submit such proposals to the M.T.C.A., and there is no intention of deviating from the custom now.)

The cabotage routes involved in B.O.A.C.'s low-fare plans include many of those over which Eagle and Hunting-Clan have been seeking A.T.A.C. approval to operate very-low-fare services at low frequency. The B.O.A.C. report says that, if *all* these services asked for are approved, material diversion of traffic from the Corporation's services would occur—estimated to amount to £5½ million in the first full year of operation and substantially more later.

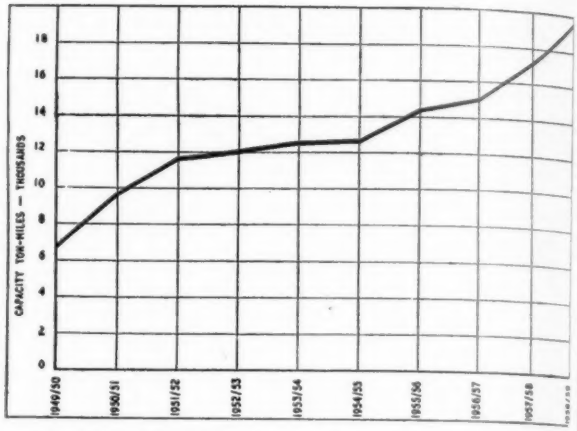
In its whole attitude towards economy-class fares *vis-à-vis* IATA, B.O.A.C. recalls that it went ahead alone in 1952 with a tourist-class service to Singapore, and that this service encouraged and accelerated the introduction of tourist class on the Eastern routes generally. In the same way, it is hoped that to introduce cheaper fares on the cabotage routes will lead to a general acceptance of these fares by IATA. No plans have been made for a further meeting of the IATA Traffic Conferences; nor does B.O.A.C. intend at the moment to take the initiative in behind-the-scenes negotiations which, it hopes, will lead eventually to agreement—in B.O.A.C.'s favour.

Future Plans

The Boeing 707 is to be introduced on the routes from London to New York, Montreal and Toronto in April, 1960, building up quickly to a daily frequency and offering an eastbound daylight service after July.

In the autumn of 1960 Boeing 707s will go through to San Francisco, and will be flying across the Pacific to Tokyo in December. In February, 1961, subject to C.A.B. confirmation of existing traffic and route rights, an Arctic service to Los Angeles will be inaugurated. Comets are likely to be withdrawn from the Atlantic in July, 1960, but Britannia 312s may stay on some Atlantic routes, particularly to the Caribbean, until the V.C.10s arrive in mid-1963.

Next month, talks with Air India and Qantas are to be continued, in India, with a view to completing a partnerships agreement between the three operators over their common routes. Talks are similarly continuing with T.C.A. and are expected to lead to an operating agreement, before the end of this year, between Montreal and Toronto on the one hand and Prestwick and London on the other. Arrangements of this kind are regarded by B.O.A.C. as preferable, at present, to any wider agreement along the lines of a Commonwealth Air Union.



ONE VITAL STATISTIC.—Although output per employee is not the only index of an airline's efficiency, it is one that is often quoted. B.O.A.C. has not compared favourably with other operators in this respect in the past. This curve gives a measure of the improvement achieved already; by 1960/61, the output per employee is expected to be not less than 35,000 c.t.m.

Associated Companies

The full list of Associated Companies in 1958-59 was as follows:—

Bahamas Airways, Ltd., and British West Indian Airways, Ltd., in the Caribbean; Middle East Airlines and Mideast Aircraft Service Co. (both based in the Lebanon), and Turkish Airlines; British International Air Lines, Ltd., Kuwait Airways; Gulf Aviation Co., Ltd., and Aden Airways, Ltd., in the Persian Gulf and Red Sea area: Ghana Airways and Nigerian Airways in West Africa; Hong Kong Airways, Ltd., Malayan Airways, Ltd., and Borneo Airways, Ltd., in the Far East.

During the year it was decided to sell the B.O.A.C. Associated Companies, Ltd., holding in Alitalia and Cyprus Airways, Ltd., to British European Airways Corporation. Associated British Airlines (Middle East), Ltd., as a holding company comprising Middle East interests ceased to function as from the end of the year.

The Corporation's investment in its airline operating Associated Companies is of the order of £14 million. Shareholdings in the various companies account for £2½ million; debentures and interest bearing loans account for £5¾ million, and the balance of £5¾ million represents aircraft and equipment supplied on hire or hire purchase terms.

Commercial Aviation Affairs

BRITANNIA DELIVERIES. — The first of two Britannia 308s for Transcontinental S.A. made its first flight, from Sydenham to Filton, on October 22. It is expected to be in service between New York and Buenos Aires next month. The first Britannia 324 for C.P.A.L. left Filton on delivery on October 16, and on the same day the first of five Filton-built 253s was delivered from Filton to Lyneham.

TASMAN COMET.—During a proving flight last week a B.O.A.C. Comet 4 flew from Sydney to Auckland, New Zealand, in 2 hr. 36 min.—or 55 minutes less than the normal TEAL schedule.

SIKORSKY S-61s ORDERED.—Los Angeles Airways has ordered five Sikorsky S-61s in the twin-engined version, for operations starting at the end of 1960. The first S-61 will fly early next year, and the L.A.A. version will carry 28 passengers and 1,200 lb. of mail and freight. Details of the three-engined S-61 were given in our previous issue; both versions have General Electric turbines—either two 1,250 s.h.p T58-8s or three 1,050 s.h.p. CT58-100s.

RESIGNATION IN ARGENTINA.—Commodore Juan Jose Guiraldes, president of Aerolineas Argentinas, has resigned, according to B.U.P. The airline has recently been criticized by the Government on the grounds of its poor economic results.

DUM DUM DEVELOPMENT.—In preparation for turbojet operations, Calcutta's Dum Dum airport now has rearranged air terminal facilities and accommodation. Two of the runways have already been extended—to 8,500 ft. and 7,000 ft.

THE DC-7F.—On October 25 American Airlines put into service the first of its 10 converted DC-7 freighters (DC-7Fs). Five of them will be in operation before 1960. The total cost of the modification programme is $4,250,000.

UNITED ARAB AIRLINE?—Representatives of five states—Jordan, Saudi Arabia, Iraq, the U.A.R. and Lebanon—have been discussing proposals for the setting up of a joint Arab airline for the operation of long-haul services.

AUSTRALIAN INCREASES.—On October 16 the fares on all Australian airlines were increased—tourist by 10% and first class by 3½%. A 30-day grace period has been allowed to overseas sales offices and on issued tickets. Since last week-end, too, coach charges are being made for all town terminal-airport journeys.

Air Transport . . . .

Another 707 Training Accident

WHATEVER may have been the immediate cause—a Boeing Aircraft Company statement speaks of "misapplication of controls"—the loss of three engine pods by the Boeing 707 which crashed on October 19 can only lead to further misgivings about the structural integrity in some extreme (but evidently possible) flight situations—more especially as a similar, but less disastrous, incident occurred only eight months ago.

The facts, so far as they are known at our press deadline, are that the Braniff Airways Boeing 707-220 (one of five on order, with JT4A engines) was on a crew familiarization flight when the accident occurred, killing four of the eight occupants. It appears that the aircraft got out of control at 12,000 ft. "during recovery from the demonstration of unusual flight attitudes," and the three engines were torn off in the violent manœuvre which resulted. It was then being flown by a Braniff captain; the Boeing check pilot on board took over and "recovered the aeroplane into level flight. With power from the remaining engine he made a controlled, wheels-up landing in the best available spot. . . ." The four survivors were at the rear of the aircraft; all suffered shock, but none was seriously injured.

Whilst the Boeing statement, with its reference to "misapplication of controls," is clearly meant to imply that the accident was the result of an error of airmanship, some wider issues require examination. In the first place, the strength of the pod and pylon structure, and its attachment to the wing, will need to be re-examined. The Boeing 707, in common with its contemporaries, has been designed to meet high flight load factors, and has been thoroughly tested to prove its structural strength. Transport aircraft are not designed, however, to endure "flick" loadings of the kind which seem to have been imposed in this accident.

Secondly, a review of the control characteristics in the difficult corners of the flight envelope is called for. The latest accident may have occurred in similar circumstances to that on February 25, when the speed dropped below the safe minimum while asymmetric power was being demonstrated on a Pan American training flight. The result, on that occasion, was that one wing dropped sharply as the aircraft went into a spin or stalled spiral dive. One engine pod and pylon was torn off, either in the initial "flick" or in the recovery.

Although the pilot may be technically at fault in allowing the speed to get too low in such circumstances, the question remains whether he is being asked to perform minor miracles in retaining control in these conditions. And it is worth remarking that, although the pilots under training in these two incidents were new to the Boeing 707, they were certainly not novices in the art of flying large and difficult transport aeroplanes.

Attention is focused on a third point by this accident. This is the question of training procedures, and the extent to which these should go beyond a demonstration of any situation reasonably likely to arise in service. It is clearly important that a pilot should be acquainted with all the characteristics of the aircraft he flies, but if the handling of an aircraft is very tricky in extreme asymmetric conditions, so that up-t the-edge demonstrations are needed, then something should be done to make it less tricky. If, on the other hand, there is no difficulty except in a case of serious mishandling, then it seems unnecessary to demonstrate a situation which will not be met in service. Two accidents and one incident involving Boeing 707s on training flights have resulted from situations which have apparently proved to be no problem with the aircraft in service.

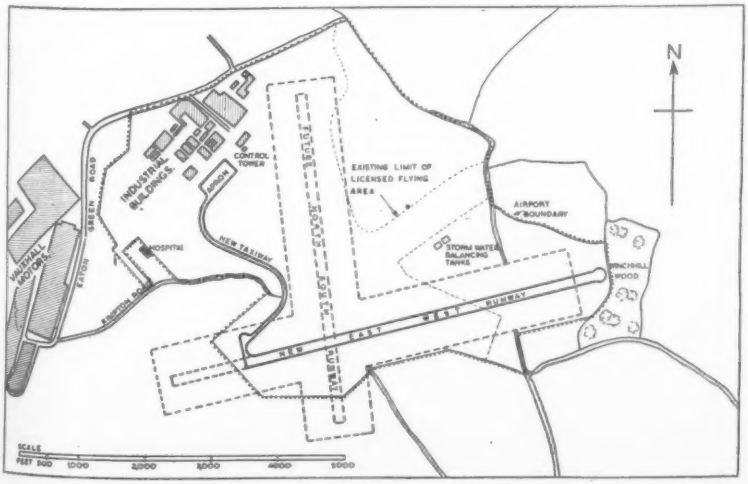
As a footnote, it can be recorded that the loss of the Boeing 707-220 will cost London insurers well over £500,000. The aircraft was insured by the Boeing Airplane Co., since Braniff had not yet accepted delivery, and 32%, or about £560,000, of the total value was covered on the London market, apart from any re-insurance contracts in London by the American insurers. We recorded in our issue of October 16 the heavy losses already suffered by aviation insurers in respect of new turbine-powered aircraft, totalling over $12 million in the present year.

KHARTOUM BOUND.—The second B.E.A. Vanguard, G-APEB, left Wisley for Khartoum on October 19, flying via Blackbushe, Rome and Cairo. It has since gone on to Johannesburg, via Entebbe and Salisbury, for about a month of high-altitude hot weather trials. Mr. G. R. Bryce (left) is here bidding farewell to the three pilots—Mr. E. B. Trubshaw, Capt. R. "Dicky" Rymer and Capt. "Mike" Mitchell of B.E.A. Extreme right is Mr. J. R. Leach, flight test manager, and next to him Mr. W. R. Peasley, navigator.

Luton Airport

NOW on the point of completion, Luton Airport's new concrete runway will, the Luton Corporation hopes, make it possible for the airport to be developed as one of London's principal air freight centres. Since 1952, Luton has had a modern control tower and a good standard of radio and navigational aids, but its use has been limited by the lack of hard runways. Three grass runways, of 5,400 ft., 4,950 ft., and 4,650 ft. in length, were available for aircraft of up to 65,000 lb. weight, but were subject to waterlogging during the winter.

The runway which has now been laid down is 6,400 ft. long, running approximately east-west, and can be extended by 1,290 ft. later, if necessary. The design of the runway is based on an equivalent single-wheel load of 45,000 lb.



As the plan printed here shows, there is at present only one taxiway with provisions for a second at the eastern end of the runway later. The taxiway has had to be curved to fit the existing airport layout, but provides for speeds of between 30 and 40 m.p.h. The location of aprons and running-up pans has similarly been dictated by the overall shape of the airport.

Work has yet to begin on a lighting installation at Luton Airport, but the outline requirements have been agreed and tenders are shortly to be invited. The installations will comprise elevated high intensity runway and threshold lighting, approach lighting extending 1,400 ft. from the runway threshold in each direction, with cross-bars at 1,000 ft. from each threshold; and centre-line taxiway lighting.

A complete survey of the runway development at Luton Airport was given by the Borough's principal engineering assistant, Mr. R. T. Davies, before the South Midland District of the Institution of Municipal Engineers on October 22.

French Transport Projects

Among the present crop of transports projected in the French aircraft industry are several of particular interest. Space available in our recent Commercial Aircraft Number (October 16) was inadequate to contain such projects but they appear in this appendix

The Hurel Dubois H.D.37

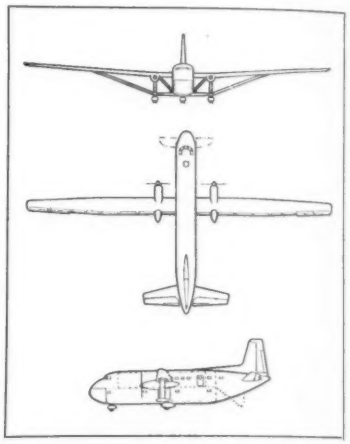
Dimensions
Span: 152 ft. 0 in.
Overall length: 85 ft. 9 in.
Overall height: 32 ft. 10 in.
Gross wing area: 1,098 sq. ft.
Sweepback: Nil.
Internal cabin dimensions:
Length (bottom deck): 53 ft. 0 in.
Length (top decks): 41 ft. 8 in.
Max. width (bottom deck): 86.5 in.
Max. width (top decks): 109 in.

Accommodation
Max. coach: 88 (4 abreast).
Volume of freight and baggage holds: Nil.

Powerplants
Two Rolls-Royce Dart 527 (R.Da.7).
Take-off power each (I.S.A., s.l.): 2,100 at 15,000 r.p.m.
Four-blade Rotol propellers, 12 ft. 6 in. diameter.

Weights and Loadings
Basic operational: 29,234 lb.
Total fuel: 9,280 lb.
Mfrs. max. payload: 18,265 lb.
Max. take-off: 51,147 lb.
Max. landing: 51,147 lb.
Wing loading (max. t.-o. wt.): 46.6 lb./sq. ft.
Power loading (max. t.-o. wt.): 12.2 lb./e.h.p.

Performance
Recommended cont. cruising speed (I.S.A.): 178 knots (at 9,850 ft. and 50,700 lb.); power (per engine): 13,000 r.p.m.
Field length required (accelerate-stop) (at max. t.-o. wt.):
At I.S.A. at sea level: 4,200 ft.
Landing distance from 50 ft. (unfactored, max. landing wt.): 3,050 ft.
Range (take-off to landing), still air, no reserves, I.S.A. max. fuel (1,144 Imp. gal): 950 naut. mi. with 12,370 lb. payload at 178 knots (mean) at 9,850 ft. (mean).
Range (take-off to landing) still air, no reserves, I.S.A., with max. payload: 440 naut. mi.



THE H.D.37 was projected by Avions Hurel Dubois earlier this year as a derivative of the H.D.34 which the company has had in production for the French Institut Geographique National. Its distinctive features are the deep, two-deck fuselage and the use of Rolls-Royce Darts instead of Wright Cyclones.

Both civil and military versions have been projected. That which has aroused most interest is the vehicle ferry, in which three or four cars are carried on the lower deck, with another car on the forward upper deck and up to 24 passengers, rearward facing, on the rear upper deck. In this version, a portion of the forward upper deck can be lowered by built-in winches, to permit the vehicle to be driven on to the floor and then lifted into position. Access to the rear upper deck is by a stairway through the bottom of the fuselage.

Other proposed versions of the H.D.37 seat up to 88 passengers on the two decks or various combinations of passengers and freight. Military versions can carry various special vehicles, guns, troops or stretcher cases and sitting wounded.

Like the earlier Hurel-Dubois machines, the H.D.37 has the very high-aspect ratio wing pioneered by this company. The Dart powerplant would be identical with that of the Viscount.

The Breguet Br. 941/942

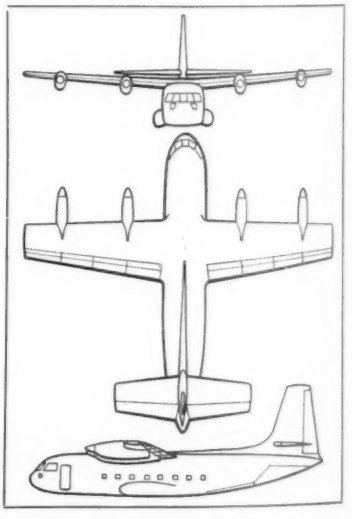
Dimensions
Span: 76 ft. 0 in.
Overall length: 71 ft. 0 in.
Overall height: 29 ft. 0 in.
Gross wing area: 890 sq. ft.
Sweepback: Nil.
Internal cabin dimensions:
Length (ex. flight deck): 42 ft. 6 in.
Max. width: 96 in.
Max. height: 88 in.
Max. usable floor area (ex. flight deck): 260 sq. ft.
Max. usable volume (ex. flight deck): 1,830 cu. ft.

Accommodation
Normal tourist: 40 (4 abreast).
Max. coach: 48 (4–5 abreast).
Volume of freight and baggage holds: Nil.

Powerplants
Four de Havilland Gnome P.1200.
Take-off power each (I.S.A., s.l.): 1,250 s.h.p.
Propeller diameter: 14 ft. 9 in.

Weights and Loadings
Basic operational: 23,000 lb.
Mfrs. max. payload: 15,000 lb.
Max. take-off: 44,000 lb.
Max. landing: 40,000 lb.
Wing loading (max. t.-o. wt.): 49.4 lb./sq. ft.
Wing loading (max. landing wt.): 44.9 lb./sq. ft.
Power loading (max. t.-o. wt.): 7.33 lb./s.h.p.

Performance
Recommended cont. cruising speed (I.S.A.): 217 knots.
Take-off distance to 35 ft. (four engines) (at max. t.-o. wt.):
At I.S.A. at sea level: 1,180 ft.
At I.S.A. at 3,000 ft.: 1,620 ft.
Landing distance from 50 ft. (unfactored, max. landing wt.): 900 ft.
Range (take-off to landing), still air, no reserves, I.S.A., max. fuel: 1,500 naut. mi. with 6,850 lb. payload.
Range (take-off to landing), still air, no reserves, I.S.A. with max. payload: 500 naut. mi.



IMPRESSIVE results have been obtained by Louis Breguet with their research prototype Br. 940, an STOL type making use of slipstream boost from four large-diameter propellers (see THE AEROPLANE AND ASTRONAUTICS, October 9). In the light of these results, project studies have been completed for a larger aircraft of the same type, and construction of a prototype of this large type is understood to have started.

The project is in two forms—the Br. 941 military or civil freighter and the Br. 942 passenger transport. The former incorporates clam-shell rear-loading doors and a freight floor; the latter has airstairs at the forward door and in the rear-fuselage floor, à la Caravelle, and seats for 40-48 passengers in the cabin.

Apart from the fuselage (the Br. 942 is pressurized) the two types are similar. Like the Br. 940, they have full-span flaps which serve to deflect the slipstream downwards and increase the lift. The outboard section of the flaps can be operated differentially as ailerons. Full-span leading edge slats are also fitted to obtain the best possible take-off and landing performance.

At restricted weights, the Br. 941/942 will be able to operate safely out of 1,000 ft. fields; as shown in the table, the take-off distance to 35 ft. with four engines, at the projected maximum weight of 44,000 lb. is 1,180 ft.

The Max Holste Super Broussard

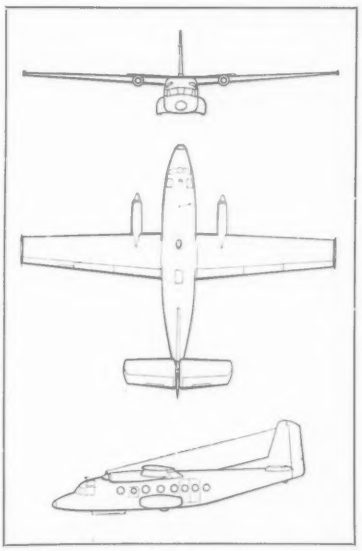
Dimensions
Span: 71 ft. 8 in.
Overall length: 58 ft. 1 in.
Overall height: 20 ft. 11 in.
Gross wing area: 592 sq. ft.
Sweepback: Nil.
Internal cabin dimensions :
Length (ex. flight deck): 21 ft. 4 in.
Max. width: 86 in.
Max. height: 78 in.
Max. usable floor area (ex. flight deck): 199 sq. ft.
Max. usable volume (ex. flight deck): 1,293 cu. ft.

Accommodation
Normal first-class: 17 (3 abreast).
Normal tourist: 20 (3 abreast).
Max. coach: 23 (3 abreast).
Volume of freight and baggage holds: Nil.

Powerplants
Two Turboméca Bastan turboprops.
Take-of power each (I.S.A., s.l.): 950 e.h.p. at 33,000 r.p.m.
Ratier v.p. three-blade propellers.

Weights and Loadings
Basic operational: 11,095 lb.
Total fuel: 3,307 lb.
Mfrs. max. payload: 8,800 lb.
Max. take-off: 21,165 lb.
Max. landing: 21,165 lb.
Wing loading (max. t.-o. wt.): 35.7 lb./sq. ft.
Power loading (max. t.-o. wt.): 11.14 lb./e.h.p.

Performance
Recommended cont. cruising speed (I.S.A.): 205 knots (at 9,850 ft. and 18,078 lb.); consumption: 108 Imp. gal./hr.; power (per engine): 740 s.h.p.
Approach speed (at max. landing wt.): 63 knots.
Field lengths required (accelerate-stop) (at max. t.-o. wt.):
At I.S.A. at sea level: 2,191 ft.
At I.S.A. +20°C. at sea level (at 18,519 lb.): 2,509 ft.
Landing distance required (I.S.A., max. landing wt.): 2,368 ft.
Range (take-off to landing), still air, no reserves, I.S.A., max. fuel (410 Imp. gal.): 755 naut. mi. with 6,750 lb. payload at 205 knots (mean) at 9,850 ft. (mean).
Range (take-off to landing) still air, no reserves, I.S.A., with max. payload: 275 naut. mi.



AVION Max Holste has recently signed an agreement with the Société Nationale Nord Aviation for the joint development of the Super Broussard, with a measure of Government support. A new prototype is due to fly next spring, and will be in the MH-260 production configuration with two Turboméca Bastan turboprops and a slightly longer fuselage than the existing prototype. Work has also begun on a small pre-production batch, for delivery in 1961.

Powered by two Twin Wasp R-1340 piston engines, the MH-250 prototype flew on May 20, 1959, and in the first three months of trials this prototype completed 103 hours in 82 flights. It is shortly to go to the Test Centre at Bretigny.

The MH-260 is intended as a general purpose short-haul transport, capable of operating in undeveloped areas but providing adequate standards of comfort and performance for use as a feeder-liner for trunk routes. It will be certificated to the requirements of the French AIR 2051 code and the American CAR4b and SR-422A.

Structurally, the Super Broussard is straightforward. Control surfaces are fabric covered and manually controlled. Flap actuation is hydraulic. The location of the main undercarriage in fuselage-side fairings is unusual in so small an aircraft.

Normal accommodation is for 23 passengers, three abreast at 30-in. seat pitch; an alternative de luxe layout has 17 seats at 40-in. pitch. Both versions have a toilet compartment at the rear and a small galley between the two-crew cockpit and the cabin.

The Sud-Aviation Diplomate

Dimensions
Span: 54 ft. 11 in.
Overall length: 41 ft. 2 in.
Overall height: 19 ft. 10 in.
Gross wing area: 433 sq. ft.
Sweepback: Nil.
Internal cabin dimensions:
Length (ex. flight deck): 28 ft. 0 in.
Max. usable floor area (ex. flight deck): 126 sq. ft.
Max. usable volume (ex. flight deck): 523 cu. ft.

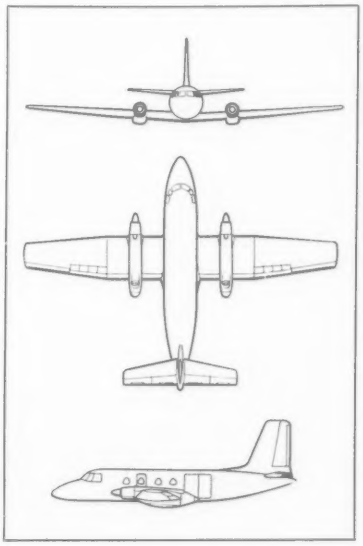
Accommodation
Normal first-class: 10.
Max. coach: 12.
Volume of freight and baggage holds: Nil.

Powerplants
Two Turboméca Bastan turboprops.
Take-off power each (I.S.A., s.l.): 800 e.h.p. at 33,000 r.p.m.
Ratier Figeac three-bladed propellers, 9 ft. diameter.

Weights and Loadings
Basic operational: 10,400 lb.
Total fuel: 3,070 lb.
Mfrs. max. payload: 2,250 lb.
Max. take-off: 15,100 lb.
Max. landing: 13,450 lb.
Max. zero fuel: 12,400 lb.
Wing loading (max. t.-o. wt.): 35.0 lb./sq. ft.
Wing loading (max. landing wt.): 31.0 lb./sq. ft.
Power loading (max. t.-o. wt.): 9.45 lb./e.h.p.

Design Criteria
Design limit speeds: Vc=243 k. Vne=315 k. Vd=350 k.

Performance
Recommended cont. cruising speed (I.S.A.): 275 knots (at 20,000 ft. and 13,450 lb.); consumption: 70 Imp. gal./hr.; power (per engine): 80% take-off.
Approach speed (at max. landing wt.): 85 knots.
Balanced field lengths (SR-422A at max. t.-o. wt.):
At I.S.A. at sea level: 3,030 ft.
At I.S.A. +15°C. at sea level: 5,000 ft.
Landing distance (SR422A, max. landing wt.): 1,430 ft.
Range (take-off to landing), still air, no reserves, I.S.A., max. fuel (382 Imp. gal.): 1,420 naut. mi. with 1,870 lb. payload at 270 knots (mean) at 20,000 ft. (mean).
Range (take-off to landing) still air, no reserves, I.S.A., with max. payload: 1,240 naut. mi.



THIS design study by Sud-Aviation is a derivative of the S.E.117 Voltigeur Army support aircraft, having the same wings and powerplant as the latter but a new fuselage. Of circular section, the fuselage provides for 8, 10 or 12 passengers, and the aircraft is offered as a fast executive transport or for military liaison duties.

The windows are of the unusual triangular shape used in the Caravelle, and the cabin is pressurized and air conditioned, with air bled from the engines. Airstairs are provided in the door at the rear end of the cabin, and a baggage locker is provided opposite this door, with additional baggage space forward. A toilet is located at the rear of the cabin.

The cockpit is laid out for two-crew operation, with provision for extensive navigation and radio equipment. The windscreens conform to the latest S.A.E. recommendations. The whole design has been made to the requirements of CAR4b, and the performance calculations are based on SR-422A.

Like the Voltigeur, the Diplomate is designed to operate from grass strips as well as hard runways. As the specification shows, the Diplomate will operate, with typical reserves, over ranges approaching 1,000 naut. miles.

The Fighting Services

Higher Standards at Cranwell

STARTING in September, 1961, the required academic standard of candidates for cadetships at the R.A.F. College, Cranwell, will be raised. From that date entry through the Navy, Army and Air Force Entrance Examination set by the Civil Service Commissioners will be discontinued. Instead, candidates will be required to have passes at Advanced Level in at least two subjects of the General Certificate of Education, as well as an acceptable pattern of subjects at Ordinary Level.

The Air Council would have preferred to make this change at once, but to avoid difficulties for boys who are already working to the present standards, they are deferring it until the September, 1961, entry. The present standards will be acceptable until then, but preference will be given to boys with two passes at Advanced Level.

At the same time as the raising of the entry standard the academic syllabus is to be broadened. Levels of instruction and achievement will be raised and all cadets will not follow the same course, but will concentrate on subjects for which they show particular aptitude. Non-specialist cadets will follow a more general course covering both science and humanities.

All successful cadets will be commissioned at the end of the Cranwell course which will still be three years. To allow time for the enlarged syllabus some of the flying training now at Cranwell will be deferred to a post-graduate phase, but General Duties cadets will still receive their wings on passing out from the College. In addition to the formal flying training given in the second and third year, cadets will put in some flying training in light aircraft during their first year.

On graduation the successful pilot cadet will have completed his basic flying training on the Jet Provost and will be awarded his flying badge. He will then complete his advanced flying training at an Advanced Flying Training School alongside direct-entry pilots. Light aircraft flying (on Chipmunks) has been introduced into the early stages of the Cranwell course to meet the natural impatience of the G.D. cadet to start flying.

Antarctic Detachment

TWO R.A.F. pilots, Flt. Lt. R. A. Lord and Flt. Lt. D. English, and three servicing N.C.O.s are accompanying the Falklands Islands Dependencies Survey on its annual relief voyage to the Antarctic this year. They are to operate the Otter and Beaver which are providing air reconnaissance, aerial photography and transportation in support of the geological and topographical survey parties in the field. The two aircraft are likely to remain in the Antarctic for five years.

Flt. Lt. Lord and Ch. Tech. P. Bates left the United Kingdom in the research ship "John Biscoe" on October 19 with the survey staff, and the remainder of the R.A.F. detachment will join them next year.

The object of the R.A.F. advance party is to clear a short airstrip on Deception Island for use by the Otter which, in addition to its wheels, is fitted with skis. Flt. Lt. English will set out from Southampton in the Danish vessel "Kista Dan" in December. Calling at Montevideo, Uruguay, it will pick up the Otter and the Beaver before making for Deception Island. There the Otter will be uncrated and assembled and, when the Survey team reaches it, flown to their base at Stoninton Island in south-west Grahamland.

The Beaver will be assembled on board ship or on the ice edge on arrival and used to guide the two ships through the pack-ice.

Gordon Shephard Prize Award

GROUP CAPTAIN M. M. GARDHAM, of Headquarters, Technical Training Command, has won the 1959 Gordon Shephard Memorial Prize Essay Competition. Second prize has gone to Air Cdre. D. N. Kington-Blair-Oliphant, a Director in the Air Ministry. Sqn. Ldr. G. C. T. Richards, of Headquarters, Flying Training Command, was third, and Gp. Capt. W. Carter, of the Joint Services Staff College, fourth. Sqn. Ldr. Richards gained second prize in the 1958 competition, and Gp. Capt. Carter was the first-prize winner in 1955, 1956 and 1957.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Wg. Cdr. J. F. Oliver to the Department of the Chief of the Air Staff.

Bomber Command: Wg. Cdr. N. G. O'Brien, M.B.E., to R.A.F. Marham as Senior Technical Officer.

Fighter Command: Sqn. Ldr. D. W. H. Smith, A.F.C., to R.A.F. Wattisham to command No. 41 Squadron, with the acting rank of Wg. Cdr.

Coastal Command: Wg. Off. S. P. Titcombe, O.B.E., W.R.A.F., to Headquarters, as Command W.R.A.F. Officer.

Transport Command: Sqn. Ldr. K. R. Richardson, D.F.C., to Christmas Island to command the Administrative Wing, with acting rank of Wg. Cdr.

Technical Training Command: Wg. Cdr. B. S. Jones, D.S.O., D.F.C., to R.A.F. Bridgnorth to command the Training Wing.

Maintenance Command: Wg. Cdr. K. W. Lawrence to Headquarters, No. 41 Group, for operations duties.

R.A.F. Germany: Wg. Cdr. J. R. Bloxham, O.B.E., D.F.C., to Headquarters, for work study duties.

Middle East Air Force: Wg. Cdr. K. R. Penry to R.A.F. El Adem to command the Administrative Wing.

Far East Air Force: Wg. Cdr. W. K. Bell to R.A.F. Seletar as Senior Technical Officer.

Other Appointments: Wg. Cdr. B. L. Duigan, D.S.O., D.F.C., to R. Malayan A.F. Kuala Lumpur, to command; Wg. Cdr. J. M. Gilchrist to the Ministry of Defence as Secretary, Chiefs of Staff Committee; Wg. Cdr. D. E. Hilliard to the Ministry of Aviation.

Reunions

U.S.N.A.S. Pensacola.—A reunion will be held on November 28 at the Feathers Hotel, Broadway, London, S.W.1, of Fleet Air Arm and R.A.F. personnel who were stationed during the War at U.S. Naval Air Station, Pensacola, Florida. Particulars can be obtained from Mr. L. V. Armstrong, 47 Rutland Road, Wanstead, E.11.

Aberdeen U.A.S.—The annual dinner of Aberdeen University Air Squadron will be held in the Royal Athenæum Restaurant, Aberdeen, on November 28. All past and present officers and members who are interested in attending are requested to write to the Secretary, Aberdeen U.A.S., R.A.F. Bedford Road Aberdeen, as soon as possible.

No. 56 (F) Squadron.—A reunion dinner will be held at Claridge's, London, on November 20. Full details are available from Flt. Lt. C. C. Rustin, No. 56 Squadron, R.A.F. Wattisham, near Ipswich, Suffolk.

MIDDLE EAST DETACHMENT.—On a reinforcement exercise in Cyprus, No. 33 Squadron, (Wg. Cdr. N. Poole) from R.A.F. Wattisham was due to fly to the R. Hellenic A. F. base at Larissa in Eastern Greece on October 29, for a three-day visit. The Squadron, equipped with Hurricanes, operated in Greece from February to April, 1941, and present members are seen with some of their Javelin FAW.7s before leaving the United Kingdom.

North American's Mach-3 Bomber

NO aircraft under development in America today is more significant than the North American B-70 Valkyrie. To the U.S. aircraft industry this Mach-3 bomber represents not only a big technical advance and an expensive and doubtless profitable development programme, but also the chance of gaining practical knowledge about the design and operation of large high-supersonic aircraft. This could give the industry an unrivalled background for the development of supersonic airliners.

To the U.S.A.F. the B-70 represents a manned deterrent to set beside its long-range missiles. Strategic Air Command believes implicitly in the manned bomber as well as the missile and the Valkyrie is a vital link in its future planning. Following the present and future versions of the B-52 S.A.C. will have the supersonic-dash B-58 Hustler and then the B-70. Further ahead will come the DynaSoar and perhaps even more exotic manned space vehicles will follow.

The B-70 is a delta-winged aircraft which will weigh about 500,000 lb. Its first flight is expected to be in 1962. Powered by six General Electric J93-3 turbojets, it will probably use afterburning in cruising flight. The B-70 will operate from existing B-52 bomber bases and will carry air-launched ballistic missiles and the largest nuclear weapons. According to a U.S. source the B-70's speed will be more than 2,000 m.p.h., its ceiling 80,000 ft. and its unrefuelled range 8,000 miles. Dimensions quoted are span 115 ft., and length 170 ft.

Development

Research on WS-110A—as the B-70 programme was first known—began in 1955; the aim was to produce a supersonic bomber which could cruise at heights over 70,000 ft. An unrefuelled range similar to that of contemporary U.S. bombers was specified.

In November, 1955, North American and Boeing were awarded study contracts for the project and they received further contracts to "advance the state of the art" a year later. In October, 1957, a U.S.A.F. evaluation team visited North American and two months later, on December 23, 1957, the company was given the development contract for this "supersonic intercontinental bomber," to quote James A. Douglas, secretary of the U.S.A.F.

At this time the aircraft was scheduled to use high-energy chemical fuels and Mr. J. H. Kindelberger, the North American chairman, said that it represented "one of the greatest design breakthroughs in the history of aircraft development." He also stated that the company's Los Angeles division would have primary responsibility for the development programme.

Dr. Hugh L. Dryden, then director of NACA, gave evidence about the project's background before a Congressional committee in February, 1958. He said:—

"The chemically fuelled bomber is of extreme importance. This is a bomber that will fly non-stop over roughly the same distance as a B-52 and make that flight at a speed very much greater. A year or so ago, the Air Force was reconciled to the idea that the best it could obtain in the way of performance from such a new large bomber would be what the engineers call high subsonic cruise plus supersonic dash, similar to the B-58.

"About a year ago, a strange and wonderful thing happened. It was as if the pieces of a jigsaw puzzle began falling into place. Almost simultaneously, research programmes that had been underway at the NACA Labs. in Virginia, California and Ohio began to pay off. The result—this is an over-simplication, but it is not an overstatement—was that the companies and the Air Force suddenly realized it would not be much harder to design a long-range bomber that could fly its whole mission supersonic than to design one that would fly subsonic most of the way, and only a small fraction of the flight supersonic. Not only that, but the top speed of the prospective bomber was raised to Mach 3, about 2,000 m.p.h.

"This new supersonic bomber, the WS-110A, will require refinement in design details to a degree that probably has never before been attempted in engineering practice. What follows about the NACA contributions to the design in no way detracts from the enormously difficult task that faces North American Aviation, winner of the competition, in designing and constructing this airplane.

"Three main factors are involved, in each of which design practice must be pushed into the limit of man's capability. These are: aerodynamic efficiency; structural efficiency; and propulsion efficiency. In each of these categories, the NACA has made contributions that are absolutely vital."

In February, 1958, the U.S.A.F. announced that the aircraft would be known as the B-70 and the North American weapons system manager said that its study, research and preliminary design phases had been completed. He also said that its performance was based on standard jet fuels although maximum use would be made of exotic fuels if available without modification to the aircraft. This is interesting in view of the recent U.S. decision to cancel production of the boron-based high-energy fuels originally scheduled for the B-70.

In March, 1958, Mr. Kindelberger revealed that the aircraft would carry air-launched ballistic missiles. And the head of the U.S.A.F. Air Research and Development Command said that 14,500,000 engineering man-hours would be needed for its development, a 70-fold increase on the wartime B-17.

A key stage in B-70 development came early this year when in March the aircraft passed its development engineering inspection, which ensured that the aircraft conformed with U.S.A.F. specifications. In April the mock-up conference was held to check its operational suitability.

Recently, the project has passed through a difficult stage; in September the U.S. decided to cancel the production of boron-based fuels and a few days later the development of the F-108 long-range Mach-3 interceptor was ended. This aircraft, virtually a scaled-down B-70, was being developed by North American in parallel with the Valkyrie. Its demise has cast a shadow over the future of the B-70, and, despite intense military resistance, this very advanced—but exceedingly expensive—bomber may be axed before its first flight in 1962.

A U.S.A.F. campaign is being waged in favour of the B-70 and Gen. Thomas D. White, U.S.A.F. Chief of Staff, has suggested that such an aircraft could be used for a wide range of duties—offensive, defensive, reconnaissance and even for the air-lift troops and weapons. Some of these suggestions seem a little impractical—for instance, bomber and transport fuselages normally have little in common—but clearly the U.S.A.F. is doing all in its power to keep the project alive.

Subcontractors

Many leading U.S. companies are involved in B-70 development, and only about 30% of the total expenditure on the programme will go to North American. Subcontractors include Boeing, responsible for design and construction of the wing, which is built from stainless-steel honeycomb sandwich panels. Wing-tips will pivot downwards to improve stability in supersonic flight; the mechanism is being produced by Curtiss-Wright.

Other companies involved are Chance Vought, tail unit and foreplane; Hamilton Standard, air-intake control system and air-conditioning and pressurization systems; Lockheed, Georgia division, fuselage section; Sperry Gyroscope Co., twin-gyro platform for attitude and heading reference; Sundstrand Aviation, secondary power systems; Cleveland Pneumatic Industries, landing gear; AiResearch, central air data; Westinghouse, electronic counter-measure system; I.B.M., stellar-inertial and radar bombing and navigation system; Beech Aircraft, "alert pod."

In the U.S. budget for fiscal year 1960—the year to June 30, 1960—President Eisenhower said: "In the field of manned aircraft much of the effort in 1960 will centre on the development of new types of aircraft such as the B-70 and F-108 which will operate in high supersonic speed ranges and on the attendant problems of structure, propulsion, navigation, communications and other equipment and components." But the F-108 is now dead and the B-70 is the last bastion remaining to the U.S.A.F. and the American aircraft industry with a future defence policy based mainly on missiles—a policy which Britain adopted more than two years ago.—J.R.C.

The R.Ae.S.—I.A.S. Conference

Selected Points from

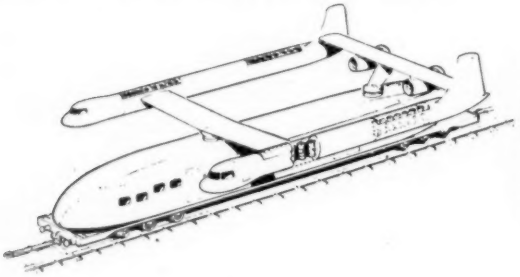
A FEATURE of the recent Anglo-American Conference in New York was the wide range of subjects covered. Summarized here are a few of the points made at the conference. Photographs of the delegates appear on page 401.

VTOL ENGINES

MR. H. PEARSON, Rolls-Royce chief research engineer, discussed various types of VTOL engine and he concluded that simple jet-lift engines might well be a better solution than ducted-fans. They were likely to be lighter and simpler to install.

He said that future jet-lift engines might have specific weights as low as 0.06 compared with 0.112 for the RB.108. The latest knowledge of compressor and combustion - chamber performances would be coupled with new construction techniques and materials, particularly plastics. The low specific weight predicted was likely to be obtained up to an engine thrust of 5,000 lb. With such light engines the basic weight of an aircraft's lift engines would be little more than current undercarriage weights.

One VTOL application suggested by Mr. Pearson was an inter-city vehicle. This would have a detachable body which would run on railway lines from mainline stations to one of several dispersal points. Here the body would be hooked on to a flying wing with the necessary lift and propulsion engines; one possible version is the "flying picture frame" shown on this page.



ROLLS-ROYCE AIRBUS.—This railbus could be lifted from its chassis and flown between cities by its "flying picture frame" which has wings, lift engines and propulsion engines. The scheme was mentioned by Mr. Pearson of Rolls-Royce.

CIVIL AIRWORTHINESS

A range of current airworthiness problems was discussed by MR. WALTER TYE, chief technical officer of the Air Registration Board. One point he examined was the effect of increased safety on air transport costs. He broke the cost of transport into three elements —A, the cost of providing transport of a given degree of comfort and speed without regard for safety; B, the cost of securing a given degree of safety, and C, the cost of accidents. A is constant, but B will increase and C decrease as safety is increased.

A diagram giving Mr. Tye's conclusions in this respect is shown here. He suggests that at present we may be close to an optimum.

Another problem discussed was the proving of new aircraft before they enter service. If, for example, 20,000 hr. of route proving were necessary, the cost would be equivalent to the purchase price of 20 aircraft—an enormous amount to write off over the production run.

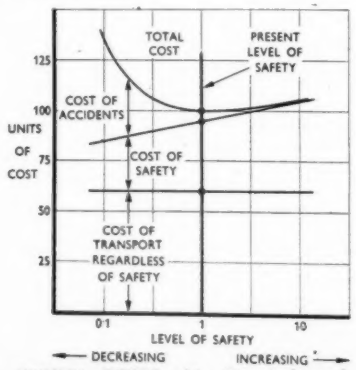
To achieve the same object more cheaply Mr. Tye suggested greater use of ground-rig testing, flight-simulator training to show up difficulties arising from unforeseen behaviour of aircrew, and intensified proving flying. For example, take-off or landing snags could be shown up by a series of short flights rather than the longer ones of route flying.

HYPERSONIC VEHICLES

Heating problems have received priority in design studies for hypersonic vehicles and the stability and control problems have tended to follow as though of secondary importance, according to MR. H. METCALFE, chief aerodynamicist of the Bristol guided weapons department. Vehicles would enter the atmosphere and fly progressively through hypersonic, supersonic, transonic and subsonic regions, making the design problem very difficult.

Any control system of a hypersonic vehicle was bound to be at least partially automatic. Missile experience had shown that an integrated design was necessary, with the control system considered at the earliest stage; later modifications might completely unbalance the design. The aerodynamicist must have information to solve his detail problems in the project stage. But the difficulties of comprehensive wind-tunnel and possibly flight tests of hypersonic configurations might involve considerable delay. This was very unfortunate when reliable motors were available for high Mach propulsion.

According to Mr. Metcalfe, the idea that aerodynamic characteristics were known for all velocities above Mach 5 was not valid.



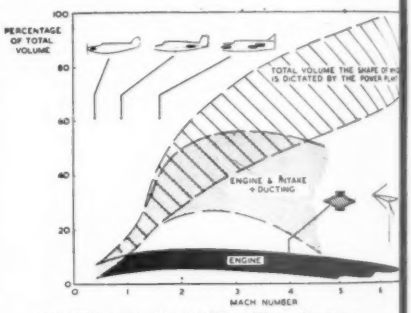
SAFETY COSTS.—Mr. Tye indicated how operational cost varies with changes in the safety level.

Discussing aerodynamic shapes, he said that rounding of leading-edges and noses was necessary for hypersonic vehicles because of the excessively high heat-transfer rates to pointed bodies. The nose radius could not be increased indefinitely and should be balanced against the consequent drag and the effect on performance. In any specific design sweepback, nose blunting and the attendant drag must be carefully matched.

He considered that apart from anti-missile applications, a modified delta wing with leading-edge droop would satisfy all stability requirements over a wide range.

The most effective control aerodynamically was the leading-edge or moving-nose control; it did not suffer from shielding and Reynolds number effects were minimized. But it presented engineering problems because of heating and air loads.

Rear controls were limited in usefulness by shielding and thick boundary layers, but tip controls and all-moving wings could be used. The moving cone-tip control might have structural, aerodynamic and heating advantages over a conventional flat-plate control.



ENGINE INFLUENCE.—This diagram from Mr. Metcalfe's papers indicates the dominant effect of the propulsion system on the shape of high-speed aircraft.

BLIND-LANDING PROBLEMS

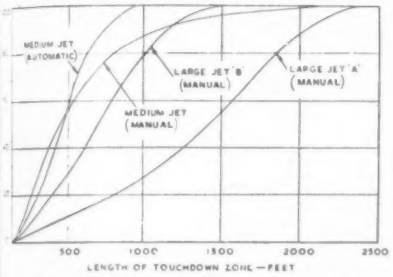
MR. W. J. CHARNLEY, superintendent of the R.A.E. Blind Landing Experimental Unit, spoke of the Unit's work. He said that the B.L.E.U. automatic landing system had been extensively flight tested in all weathers. It was flexible and easily adaptable if improved guidance elements were developed in future. Its landing performance was better than that achieved with manual landings in good visibility.

Its application to civil aviation was discussed. The outstanding problem on the airborne side was achievement of the safety needed for routine civil use; this could be done by normal development methods.

The main problem with ground installations was the development of a reliable azimuth-guidance element with sufficient accuracy which was acceptable for international use. Leader cables were accurate

...ven Papers

enough but might not be accepted because of installation problems on some sites. If they are not adopted there was an urgent need for an alternative since civil introduction of automatic landing may depend on this problem. B.E.A. and B.O.A.C. had specified automatic control in elevation to touch-down for their new aircraft, and provision for full automatic landing when ground installation problems have been settled.



AUTOMATIC LANDING.—Mr. Charnley's lecture included this graph, which shows that manual landing is considerably less accurate than the B.L.E.U. system.

A completely independent monitor for ground landing might be required. A system which produced an airborne pictorial display of the runway in bad weather was in the early research stage.

AIR TRAFFIC CONTROL

The future of air traffic control systems was discussed by CAPT. ALDEN C. PACKARD, acting director of the U.S. Federal Aviation Agency's bureau of research and development. He said that the F.A.A. programme had been divided into three phases.

The first was the improvement of existing facilities using current equipment and proven procedures. The second was a five-year programme involving the systematic application of existing technologies for the early modernization of ATC facilities. This included an effort to put many of the routine clerical chores which were at present taxing controllers' capabilities onto a semi-automatic basis without waiting for radical new developments.

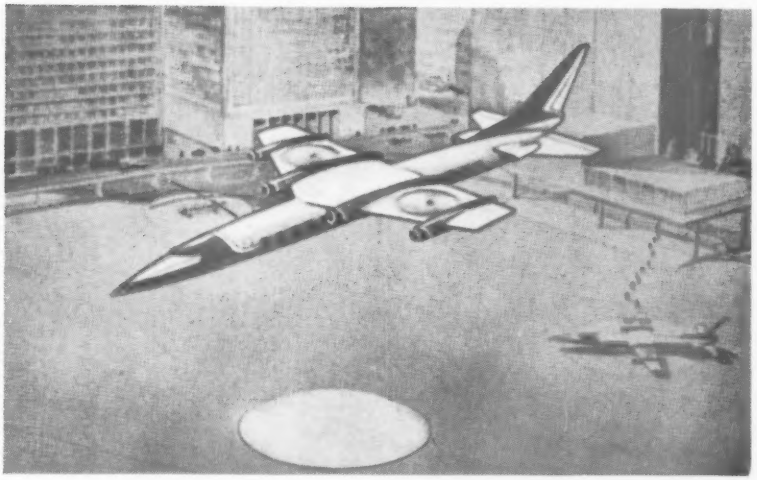
This second phase began late in 1957 and the semi-automatic system would be operating in a segment of the New York area in 1963. The third phase was a continuing research and development programme to meet present and future needs.

Discussing the programme for 1963-75, Capt. Packard said that any future ATC system would depend largely on the quality, speed and flexibility of automatic ground-air-ground communications. The F.A.A. had a contract with the Radio Corp. of America to develop an experimental two-way high-speed data link known as AGACS—automatic ground - air - ground communications system.

This would be the tool to decide the parameters for the exchange of essential routine flight information between aircraft and controller; non-routine communications, which made up only 10% of the total, would be via voice channels. AGACS would permit a direct automatic tie-in to the ATC data processor on the ground.

Eventually, improved high-speed two-way data links would, in effect, allow the controller to peer into the pilot's cockpit via the data link. Indicated airspeed, altitude, information from airborne navigation systems and other cockpit readings would be fed into the computer on the ground—which in return would transmit flight-plan information to the pilot. These refinements would make possible much more accurate positioning of aircraft in space and would ultimately lead to reductions in separation requirements.

Control of air space in future would be centralized—possibly at one point only for the whole North American continent. Air defence and ATC functions would undoubtedly be accomplished by one facility, probably located near the centre of the U.S.



LOCKHEED PROJECT.—This projected fan-lift VTOL airliner appeared in a paper on blind take-off and landing by Messrs. N. C. Harnois and G. H. Stocker of Lockheed.

FLIGHT CONTROL SYSTEMS

A paper by MR. S. A. SJOBERG, of NASA's Langley Research Center, discussed the flying qualities and pilot reactions associated with several types of command flight control system. These control systems were examined in flight tests with a Grumman Panther straight-winged jet fighter.

The systems tested were: Normal-acceleration longitudinal control, in which normal acceleration is proportional to pilot's stick deflection; pitch-attitude control, in which the angle of pitch is proportional to stick deflection; and pitch-rate control in which the angular rate of pitching is proportional to stick position. A pitch damper was used to increase aircraft damping with the latter system.

Two lateral command systems were used in conjunction with the longitudinal ones described. A roll-attitude system (bank angle proportional to lateral stick deflection) was used with the pitch-attitude system.

A roll-rate system was used with both the pitch-rate and normal-acceleration longitudinal systems. Yaw damping and turn co-ordination was used in conjunction with all control systems. Heading hold was provided with the pitch and bank attitude systems. A range of flight controls was used including conventional centrally located sticks, and side-located sticks.

Test results showed that pilots considered the attitude-control system unsatisfactory for rapid manœuvring. Flying qualities with the normal acceleration or pitch-rate systems were very good.

Such systems could overcome unsatisfactory aerodynamic stability and control characteristics and could provide such desirable features as normal-acceleration limiting, automatic trimming of pitching moments arising from changes in aircraft configuration, constant stick force per g and stick deflection per g. A miniature side-located control stick was very satisfactory for use with these systems.

RE-ENTRY ABLATION

Among aspects of ablation discussed by MR. LESTER LEES of the California Institute of Technology were the differing re-entry requirements for missiles and satellite vehicles. Different ablative materials were needed.

When a spacecraft or satellite re-entered from a circular orbit the entry angle would normally be less than 2° because of the prohibitive weight of larger retro-rockets needed for a steeper descent. The maximum convective heat transfer rates for a typical non-lifting vehicle were about 65 B.Th.U./sq. ft./sec., less than one-tenth the values encountered by a ballistic missile, and the duration of the heat pulse was about 250 secs., or ten times longer.

A grazing-entry trajectory dictated a low-density, low-temperature ablator that was also a poor thermal conductor. These properties would also minimize heat conduction to the interior during relatively long soak times.

When lift was used the re-entry heat-pulse duration increased roughly as the L/D ratio for a shallow re-entry, and both the weight of insulation and ablated material would increase. Because of the low heat-transfer rates in this case radiation from the body surface was an attractive alternative.

Combination schemes were possible. A material might be used which radiated heat over most of the trajectory and ablated only when the convective heat-transfer rate exceeded the radiating capacity of the surface.

Simplifying the Pilot's Task

Surveying some of the British developments in aircraft flight instrumentation, P. R. RAMAGE *discusses present and future cockpit displays. These include the R.A.E. Flight Data System and the "head-up" flight director electronic display for presentation in front of the windscreen.*

AS the most adaptable link in the control loop of an aircraft flight system, the human pilot has always had to make up for limitations in the flight and navigational information provided by cockpit instrument displays. This is particularly true in the case of high-performance aircraft, for the situation has reached a stage in the latest generation of military types where the shortcomings of the information displayed by the conventional instruments in general use today can be the cause of major flying errors—quite apart from limiting the full operation of the aircraft.

The fighter is the most advanced type of aircraft in terms of rates of change of position or attitude and, therefore, comes automatically to the forefront when considering these problems associated with flight data presentation. The larger jet bomber or civil transport, however, is a very close second.

Another major factor which places the single- or two-seat military type in a class of its own is that the piloting of the aircraft is only part of the overall problem of employing it as an aerial weapons platform. This requires the performance of a number of other tasks, such as navigation, radar operation and actual combat.

In this country a large proportion of the basic research into the problems of aircraft instrumentation, together with development and evaluation studies, is undertaken by the Instrument and Photographic department (I.A.P.) of R.A.E. Farnborough in close co-operation with the R.A.F. Institute of Aviation Medicine and the British instrument industry. For the majority of the latest developments in information presentation dealt with in this article, I.A.P. has, generally speaking, provided the basic conception and controlled the overall work of instruments produced under Ministry of Supply contracts. The individual manufacturers have been responsible for the engineering and detail design of the equipment.

Solutions to the problem of presenting to the pilot the right type of flight and navigational data in the right form can now be divided into three generations of instrument displays. The first consists of the well-known sensing instruments comprising six self-contained units—altimeter, compass, turn and slip indicator, artificial horizon, VSI and ASI. These are now being superseded by electro-mechanical displays working off central data sources. This second, or transitional, generation of integrated instruments will, in time, be substituted by cathode-ray tube types of information presentation.

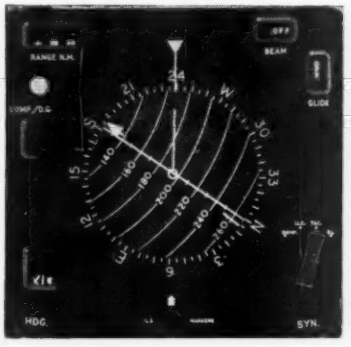
Pilots' displays have two types of information, namely, raw data and instructions on what to do—such as those provided by a flight director. On the old types of instrument, basic data and flight-director information were not presented in an integrated form. The main reason for this was the restriction on the type of display that could be used when operating from data sources within the instrument.

The use of servo-operated instruments has given considerably more freedom in display and it has been possible to produce an integrated display. The flight director is, of course, an old idea—for example, the Sperry Zero Reader—but in the new R.A.E. display it is combined with other flight data in an integrated manner.

Present progress indicates that it will be a long time before all data are transferred to cathode-ray tubes and there may always be a case for displaying quantitative information by means of an electro-mechanical display. The next step is a "head-up" flight director which, in the first instance, will supplement the information given on the pilot's panel.

The Flight Data System

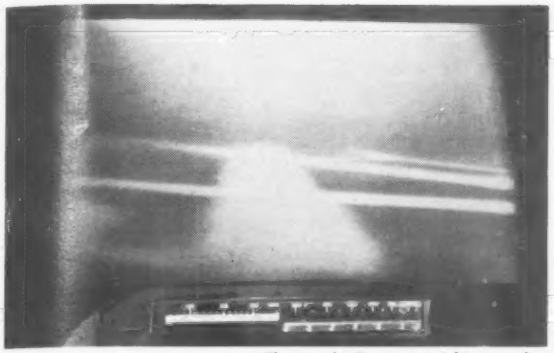
Supplying flight information to such equipment as autopilot, AI radar and weapons systems, in addition to the cockpit display, the R.A.E. Flight Data System employs two central sources of primary data to eliminate duplication of measuring and computing units. One is the air data computer, such as the Elliott equipment described in THE AEROPLANE of November 22, 1957, and the second is the master reference gyro (M.R.G.) produced by S. G. Brown, Ltd., and described in our issue of December 27, 1957. Kelvin and Hughes have also developed an air data computer, but this operates on different principles to those of the Elliott equipment.

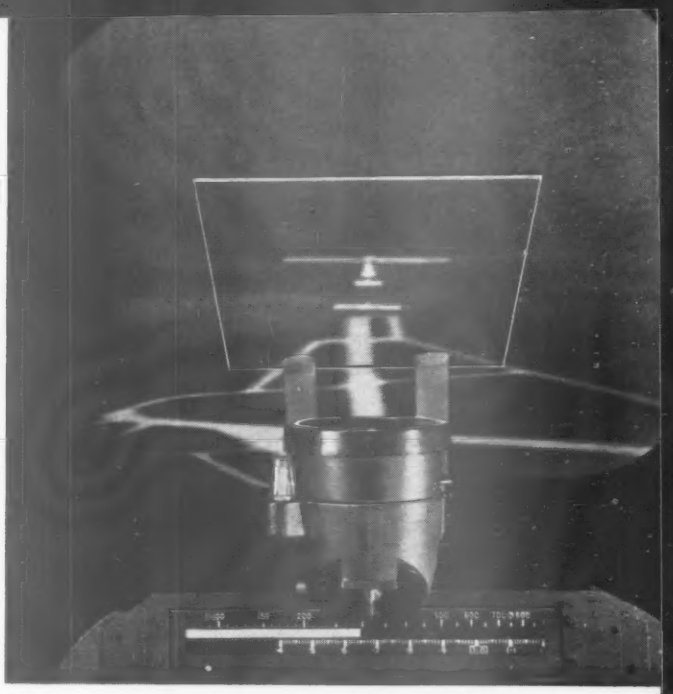


Above left, framed by a moving card compass repeater, the Flight Data System navigational display is shown in the TACAN mode. This is thought to be the first pictorial presentation of TACAN bearing and distance information, as opposed to the normal pointer and counter display.

Above right, the Flight Data System attitude indicator showing the circular director index operated by fine wires. This is a "fly-to" type of indicator.

Left, the flight and navigational display of the R.A.E. Flight Data System. This comprises the speed tape presentation along the top, and, left to right, altimeter and vertical speed indicators, roller blind attitude indicator and navigation display. The navigation display is in the ILS mode.



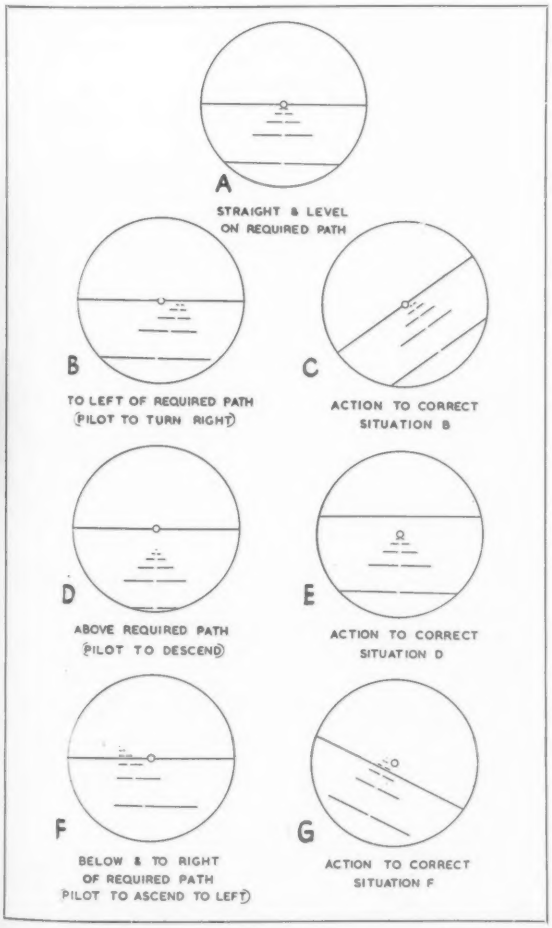


Photographs Crown copyright reserved

Photographs taken in the I.A.P. flight instrument simulator illustrating the pilot's view in flight. On the gunsight reflector (right) can be seen the horizon bar and perspective track of the collimated display described on the following page.

The air data computer, containing two master capsules for measuring static and pitot pressure, supplies outputs which are transmitted into a computer by servo mechanisms in which I.A.S. (or E.A.S.), barometric altitude, vertical speed and Mach number are computed; T.A.S. is found by the addition of a thermometer for calculating air temperature. The M.R.G. provides dynamic flight information in the form of angle of bank, elevation and heading outputs; it contains both vertical and azimuth gyros, which are mounted on a single platform so that the vertical gyro stabilizes the azimuth gyro.

From these two sources of basic flight information, in the form of dynamic and pressure data used in conjunction with a guidance computer and full automatic aircraft control (autopilot), the Flight Data System can be employed by the pilot to operate the aircraft in one of three modes. These are: full automatic control, with pilot monitoring; pilot control through the flight director, with monitoring; and pilot control, independent of autopilot.



A contact analogue form of flight director presentation suitable for an electronic collimated "head-up" display described on page 416. This comprises an horizon bar and a perspective track.

Work on the flight and navigational display for the Flight Data System, which is used for any one of the three possible aircraft operating modes, started with the attitude indicator. From flight tests undertaken by I.A.P. in conjunction with the R.A.F. Institute of Aviation Medicine it was found that the "Earth reference" presentation—where the moving element is identified with the outside world and the case with the axis of the aircraft being controlled—was preferred by pilots to the "aircraft reference" presentation, where the moving element is identified with axes of the aircraft and the case with the geographic axes.

In the conventional artificial horizon of the Earth-reference type of display the horizon bar is Earth-stabilized in bank, but not in elevation; in elevation the bar must move through the angle of elevation of the aircraft fuselage plus the angle necessary to give the required scale of presentation. In vertical flight only one degree of freedom is left for the gimbals of the vertical gyro and it can be toppled if high-precession torques are applied.

To overcome these problems, and to permit more accurate readings at high elevation angles, a number of displays were considered; these included a two-dial indicator for elevation and bank, and spherical attitude indicators. The outcome of the experiments was the now well-known Kelvin and Hughes "roller-blind" attitude indicator, designed to an R.A.E. patent, which gives a direct and continuous display of elevation and bank up to very nearly ($\pm 3°$) the vertical. The features of this display are also the work of R.A.E.

This instrument consists of a frame operated from one servo-mechanism repeating bank angle, the frame carrying a moving blind operated by a second servo-mechanism repeating elevation angle. The surface of the blind is divided into two regions, one painted white, representing sky, and the other black, indicating the Earth—the horizon bar being eliminated to avoid confusion over the frame of reference. Zenith and radar points are also marked on the blind so that the appropriate one appears before the horizon line disappears from view at the top or bottom of the display.

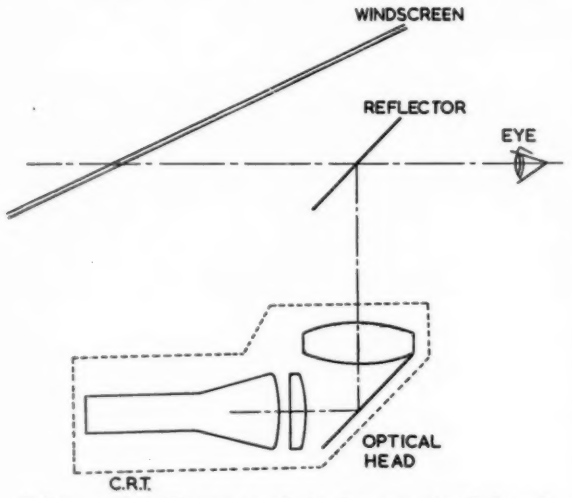
Height and Speed

During the past few years a number of experiments on tape and dial displays for altimeters have been conducted, by I.A.P. and I.A.M., to overcome the disadvantages of the three-pointer presentation. The first tests were on altitude tape displays with a non-linear scale designed to match the decreasing absolute accuracy of height measurement with increasing altitude. But with this type of presentation pilots had difficulty in maintaining a given height under a number of conditions; this difficulty was attributed to the lack of an easily discernible clue to height deviation, such as the rotating pointer of a counter-pointer indicator.

To overcome this problem and the disadvantages of

three-pointer presentation, the counter/single-pointer altimeter has been adopted for the R.A.E. Flight Data System. The particular instrument employed is the Smiths 100,000-ft. servo altimeter with a counter presentation giving height increments of 50 ft., one revolution of the hand sweep indicating 1,000 ft.

The speed display in the Flight Data System has gone from dial instruments to tape presentation. Mounted horizontally in the instrument panel to avoid the conflict between the requirements for quantitative use and for control purposes that is found with vertical presentation, the tape now fitted has a fixed I.A.S. (or E.A.S.) scale, a combined moving I.A.S. and Mach number pointer and a moving Mach number tape which



A diagram of a collimator installation for presenting flight and navigation information in front of the cockpit windscreen.

automatically adjusts for height. A non-linear scale is used for the I.A.S. tape over the aircraft's approach and landing-speed range.

Thought to contain the first pictorial presentation of TACAN bearing and distance, as opposed to the conventional pointer and counter instruments, the system's display of navigational information is framed by a moving card (Earth reference) compass repeater. The former is presented on a roller-blind mechanism, similar to the one used in the attitude indicator, with the blind divided into three sections. The first contains the TACAN navigational position information; the second an ILS beam lateral-displacement presentation; and the third display is blank.

In the pictorial TACAN mode the central fixed index of the display represents the aircraft, the blind automatically moving according to the range from the ground beacon. The frame carrying the blind rotates with respect to the compass card and a line through the beacon index shows the bearing of the aircraft from or to the beacon. A quantitative display of TACAN range and bearing is also provided. By use of the system's offset computer the reference point of the whole navigational display can be transferred to any airfield or ground position if its distance and bearing from the TACAN beacon are known.

Chosen to reduce to a minimum any confusion of interpretation, the ILS display has a double-line azimuth index on the roller blind and a servo-operated single-line elevation index attached to the roller-blind frame. The index system against which displacement and azimuth are read is viewed through a transparent portion of the blind.

There are two ways of visualizing the display. One is a cross-pointer presentation showing the position of the aircraft relative to the beam, the whole being framed by the compass card against which azimuth can be read. The other is a true plan view in which the two-line index represents the runway, the transverse index is the point at which the desired glide-path intersects the runway, and the central index represents the intersection with the ground of a flight-path of the correct angle, but passing through the present position of the aircraft.

Another display which is open to a large number of design considerations is the flight director. These include: where the display is to be situated; the signals to be fed to the director and the way in which the director index moves in relation to the signals; and the frame of reference with respect to which the movement of the director index is visually associated.

The flight director in the Data Flight System is located on the roller-blind attitude display and is of the "fly-to" type of information presentation (where the director index is interpreted as the direction in which to fly the aircraft), as opposed to the nulling pointer displacement director (where the director index is interpreted as a pointer to be brought back to a given point by means of a control movement). A circular index, operated by fine cross-wires, is used to give the minimum visual connection with the case—the main requirement of "fly-to" types of indicators.

Electronic Display

A collimated "head-up" flight director electronic display under development at I.A.P. is designed to improve the methods of instrument flight by a substantial margin. This represents the third generation of cockpit presentations of flight and navigational information. The objective of this type of display is to produce a flight director in which the gap between flying on the flight director and visual contact is reduced to a minimum.

Although the requisite skill for instrument flight can be acquired by practice (given the initial ability), there is a limit to the speed with which this art may be performed, because of the finite times involved in the transfer of attention. In certain phases of flight, such as the approach, these considerations are important because of the need either to simplify procedure for a given speed of approach, or, for a given work load, to increase the speed at which an approach may be made with safety. The aim is, therefore, twofold—to reduce the times required (a) to transfer attention between display and environment, and (b) to read the constituent parts of the display.

This new method of instrument flight, proposed by R.A.E. and engineered by Rank-Cintel, Ltd., is being tested in the I.A.P. department flight instrument simulator, where facilities are also available for simulating the pilot's view during free flight. The installation consists of a gunsight in which a cathode-ray tube (C.R.T.) is used to present a display seen at infinity by the pilot, who is able to treat it as part of his view of the external world. The display is therefore a collimated, "head-up" presentation of information which has been generated by electronic means.

Use of a collimator enables the pilot to observe the display in the same plane as the visual environment, although the present field of view is very restricted. This means that transfer-of-attention times are reduced because the line of sight has to be shifted only a small amount and the focus does not have to be altered.

It may be noted here that if the same display were shown on the windscreen (or on a flat transparent screen nearer the eyes) in uncollimated form (i.e., a real image), a change in eye-focus would be necessary to observe it. It must also be stressed that the use of a collimated display carries with it the need to simplify the display to the utmost extent consistent with the information to be displayed; this is because the display itself must cause minimum interference with the visual background.

It is also clear that any logical incongruity between display and environment must be avoided at all costs. This dictates the conventions to be used in interpreting the display.

The form of the display must be such as to permit immediate interpretation. A choice has been made between the contact analogue type of display (abstract representation by comprehensive array of perspective construction lines) and flight director. The contact analogue gives attitude information, at the expense of complexity of display, and tends to give little directive information. The flight director gives good directive information but is poor in attitude information.

Although it is much too early to say that it is better than other types, the contact analogue form of flight director can be employed. This display may be regarded as an horizon bar and a perspective track. If the track is displaced with respect to the centre of the display (which is taken to represent the direction of the flight path) and the convention is adopted that the vanishing point always tends to remain space-stabilized, the display then represents the deviations of the aircraft from a directed path in space in a way which is compatible with the apparent movements of the environment.

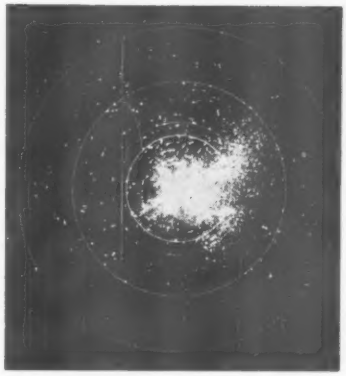
There are five main properties of this method. (1) The pilot may be guided along a given path without the use of conventional "head-down" instruments; this is done by height and heading control with automatic turning on to a new heading. (2) The facility for visual observation is retained during instrument flight. (3) The form of the display is variable—a simple flight director may be substituted for the track, or the horizon bar may be suppressed. (4) Additional information may be added in compatible form, such as an electrically generated runway. (5) Attitude and director information can be presented in the same display.

The display is being tested comprehensively by simulator techniques. The method used is to fly a fixed manœuvre whilst recording errors in heading, height and speed. This instrumental task is performed in conjunction with visual tasks set up in the visual background.

Air Defence and Control

WITH the introduction of the SAAB J35A Draken supersonic all-weather interceptor into operational service with the Royal Swedish Air Force this year and the order in 1958 for the Bristol-Ferranti Bloodhound surface-to-air guided missile system, the Swedish Government's recently announced £1½-million contract with Marconi's Wireless Telegraph Co. for a new electronic air defence system is obviously a further step in the building up of a new air defence network.

Because of Sweden's geographical shape and position, the two major problems of any air defence organization—warning time and range of operation—are very critical. So the full advantages of fast-climbing fighters and surface-to-air missiles cannot be obtained without extremely rapid collation of relative information, together with its presentation to the ground controllers for operational direction of the air battle.



A typical example of a raw radar display with a large amount of clutter present. The development of synthetic displays can be seen in the two lower illustrations.

In the Marconi system, developed by the company in close collaboration with the Swedish Air Force, these factors have obviously had major consideration. The use of a high-speed computer indicates that it is at least semi-automatic in operation; although a system with a higher degree of automation would be needed for ballistic-missile interception.

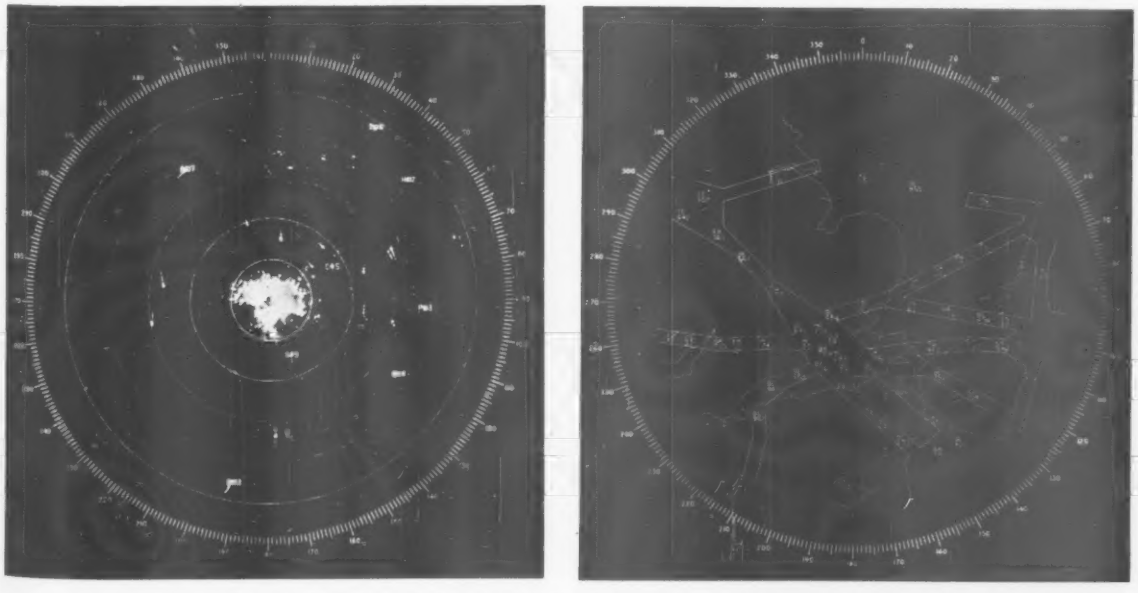
A delegation of the Royal Swedish Air Board recently visited the Marconi works at Chelmsford and the company's research and development laboratories at Great Baddow in connection with the radar order. Seen here, left to right, are, Col. Hamilton and Gen. Rapp (R.S.A.B.), Dr. Eastwood and Mr. Keall (Marconi) and Col. Lindgren (R.S.A.B.).

Other techniques are to be employed to reduce the time factor to a minimum.

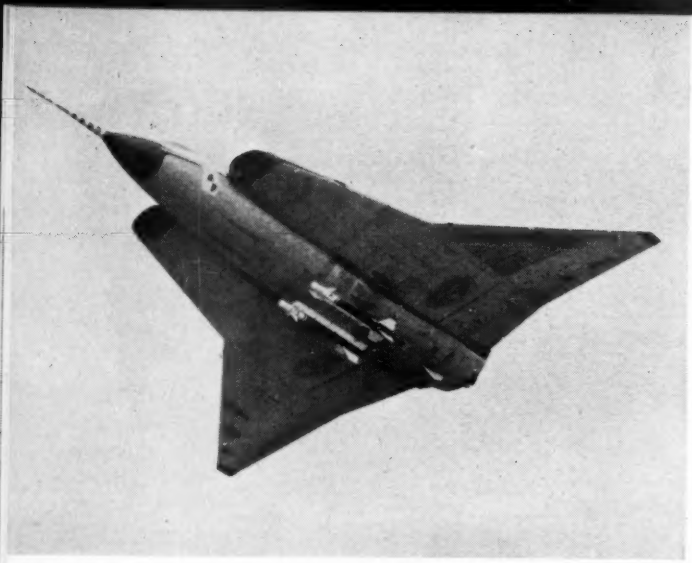
These include the parallel, as opposed to the series, build-up of information and the use of uncluttered synthetic radar displays of essential tactical data.

Additional factors designed to keep the time scale to a minimum include automatic information-dissemination and the presentation of such information to the controllers by means of monochrome and colour closed-circuit television and tabular displays, as well as synthetic and raw radar displays. Automatic tracking methods, designed primarily to overcome radar clutter areas and enemy electronic counter-measures, also help to reduce the time factor through the computer.

The colour television presentation employed is in the form of a projected display in the three primary colours based on



Left, a picture of raw radar with some synthetic symbols indicating aircraft on the display. This is a typical example of the type of display that the Swedish Air Force is likely to have. Right, a purely synthetic display showing the United Kingdom airways pattern with aircraft in symbolic form.



The improved Swedish air surveillance and operational control system has been designed to serve all air defence weapons. One of these, the SAAB J35A Draken, is now equipped with Sidewinder AMMs.

a development of Marconi's closed-circuit colour medical television system. Used to present the overall air situation to the senior controller and his specialist officers, the colour display can be projected up to a maximum size of 11 ft. square. The monochrome television pictures are employed to display ancillary operational data such as weather charts.

Swedish security forbids a detailed description of the new system. However, the use of various types of radar for providing full aircraft positional and height information suggests that the system is in many ways similar to the Royal Radar Establishment's defences system demonstrated at Malvern last year.

This depends on three types of radar. Long-range early warning and height-finding radars to give the first indication of an enemy attack and provide details of height, range and bearing to be passed to the operations centre as soon as the enemy aircraft come within range; and precision radar sets which lock on to individual targets and control defensive missiles to these targets.

In the R.R.E. system the information given by tactical control radar is plotted by operators and fed automatically into a computer which presents the position to the operational controller on synthetic radar displays similar to the Marconi equipment. These show the position of the aircraft; whether they are unidentified or hostile; and the computer channel which contains data about them. Using this information the controller can press a button which automatically gives target information from the computer store to a precision radar. When this is locked on to its target a defensive missile can be fired.

For transmitting operational commands to the pilots and controlling fighters in the air, the Swedish Air Force system is reported to employ special guidance transmitters. These can be used to operate guidance presentations on the pilot's flight instrument panel and are suitable for development to actuate the aircraft's autopilot directly without using the pilot as a control link.

Civil Traffic Control

A further special feature of the Swedish air defence system —known by the military designation "Stril 60"—is the provision of remote synthetic displays for civil air traffic control centres, civil defence organizations and public information services. Using special techniques, these can be fed over telephone lines from the military centre to the interested outside bodies.

One great advantage of this last possibility is that information from the more powerful military radar equipment can be used by civil air traffic controllers tied to relatively limited radar displays. Obviously, to get the best possible advantage from the new equipment, civil airways controllers could work within the military system, as proposed in the United States' Satin programme for SAGE (Semi Automatic Ground Environment control). In this, civil air traffic control integration with the military defence network is to be studied.

Another civil application for the Marconi system is the possible inclusion of synthetic radar displays for *en route* and terminal airway control. This, with the general use of secondary radar such as that to be installed by B.O.A.C. in its Boeing 707s for identifying aircraft by, say, their flight numbers, would ease control problems and improve air safety.—P.R.R.

U.S.-U.K. Air Traffic Control

AN agreement has been made between Decca Radar, Ltd., and General Precision Systems, Ltd. (G.P.S.), of Aylesbury, formerly Air Trainers Link, Ltd., for co-operation in the development of air traffic control equipment. The Decca Navigator Co., however, is not involved in the tie-up.

Entering the sphere of air traffic control systems and equipment for the United Kingdom, Commonwealth and European markets, G.P.S. is a British subsidiary company of the General Precision Group in the United States. The company is 53.6% American owned and its board comprises Air Chief Marshal Sir John Baker (as chairman) with eight other British directors, and three American directors. These U.S. members include Mr. J. W. Murray, chairman of the General Precision Equipment Corporation.

This development follows the G.P.S. directors' recommendation to broaden the basis of the company's business beyond its original scope of producing synthetic flight training equipment. This section of the company's work will be continued by the Air Trainers Link Division.

A new division has been created by G.P.S. to cater for these air traffic control activities. This division is headed by Mr. E. W. Pike who until joining the company had been deputy flight services manager for B.O.A.C. since 1958. He has been chairman of the Flight Technical Group of the International Air Transport Association for 10 years. On release from the R.A.F. in 1945, he was appointed deputy superintendent of navigation at B.O.A.C., and later joined the Corporation's operations branch as superintendent. In 1952, his title was changed to control and navigation superintendent.

A number of companies in the American General Precision Group are engaged in the development of new air traffic control systems for the Federal Aviation Agency (F.A.A.) General Precision Laboratory Inc. is the prime contractor to the Agency for a data processing and display centre, an important constituent of the U.S. airways modernization programme.

Other companies in the group, notably Librascope Inc. and Link Aviation Inc., are also contributing to this multi-million dollar programme. It is expected that substantial elements of an integrated air traffic control military civil system will be delivered to the F.A.A. for experimental evaluation by its Bureau of Research and Development in the next few months.

Arrangements have been made for the British company to obtain complete access to the technical knowledge and techniques that American companies in the General Precision Group have built up during their work on the F.A.A. programme. Teams from both G.P.S. and General Precision Laboratory Inc. have already made several exchange visits.

Experts from the Air Ministry and from the department now named the Ministry of Aviation have also recently visited the United States to study the F.A.A. ATC systems.

American Aircraft Electrical Systems

PROPOSALS for the flight vehicle electrical programmes for the U.S. Services in the next 5-10-year period, have now been completed by the U.S. Aircraft Electrical Systems Advisory Staff. These recommendations provide a means for all manufacturers interested in this field to save time and money in initiating their own equipment development programmes. They follow the Advisory Staff's annual review of the U.S. Navy's Bureau of Aeronautics and U.S.A.F. presentations of long-range weapons research and development programmes.

Under the recommendations are approximately 100 items which are considered to be of major importance in producing electrical systems adequate for the planned U.S. missiles, space vehicles and aircraft. Suggested items range from improvements in electrical components to the generation of electricity from nuclear energy for space vehicles. The report emphasizes the need for the development of energy conversion processes for satellite electrical power sources and puts priority on such items as variable speed, constant frequency, environment free generators and a space environment test facility.

The Staff, a purely advisory group meeting under the chairmanship of a permanent U.S. Government official, was formed in 1951 and its activities include an inspection visit to the British aircraft industry in 1954. Copies of its recommendations can be obtained from the Airborne Equipment Division of the Bureau of Aeronautics, Department of the Navy, Washington, 25, D.C., U.S.A.

Astronautics and Missiles

The Ramjet and Astronautics

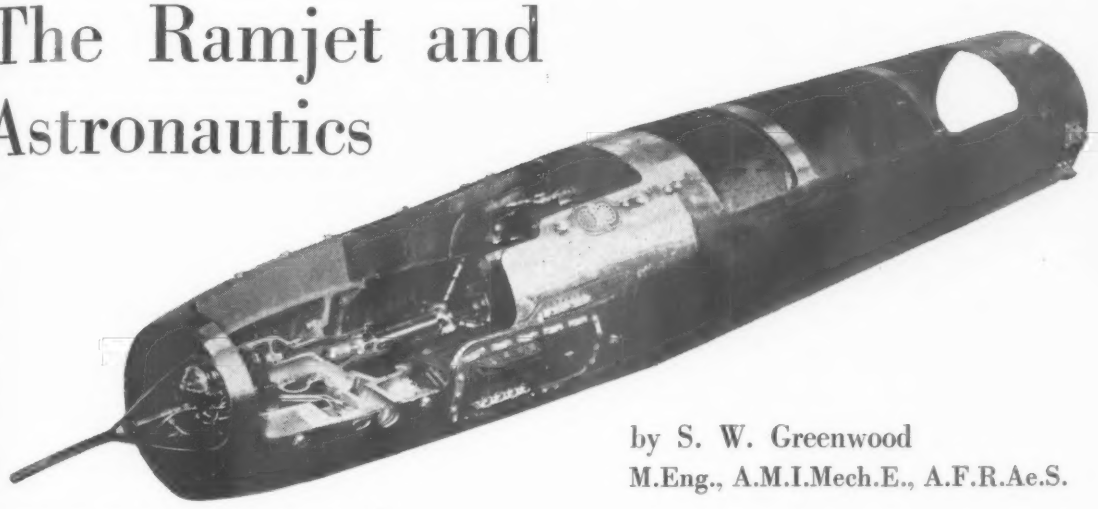


Fig. 1. The Bristol Siddeley Thor ramjet.

by S. W. Greenwood
M.Eng., A.M.I.Mech.E., A.F.R.Ae.S.

AT present the chemical rocket motor appears to occupy a dominant position in astronautics, if only because of its ability to operate in the near-vacuum of space. However, it is probably only a matter of time before the rocket shares the honours as an astronautic powerplant with the ramjet.

How is it that an atmosphere-breathing engine can be considered in this connection? It must be borne in mind that all space flights that start from the Earth necessarily have to traverse its atmosphere. Most of the planets in the Solar System possess atmospheres, and some of their moons will have them too. If these atmospheres can be used in the propulsion of the vehicles that pass through them, then clearly savings in the propellent carried by these vehicles will be possible. The fact that the greater proportion of the mass of a typical present-day space vehicle consists of propellent is sufficient to encourage examination of the possibility of alleviating this undesirable situation.

Of the various atmosphere-breathing engines available, the ramjet is the most attractive, although it has its own particular limitations. Unfortunately there is less engineering data on the ramjet than on the rocket in the security-unclassified literature. However, an attempt will here be made to present a fair comparison of the two types of engine.

Propellent Economics

A modern supersonic ramjet, the Bristol Siddeley Thor (Ref. 1), is shown in Fig. 1. The fuel storage and turbo-pump systems are not shown, as these are separate from the engine itself. In complexity these items compare favourably with those for a rocket.

The parallel combustion chamber and the convergent-divergent exhaust nozzle are reminiscent of the rocket, but the differences between the two engines become apparent when one considers that the larger proportion of the propulsive fluid, air, has to be taken-in by the ramjet through the air intake ahead of the combustion chamber. The intake is seen to occupy approximately half the length of the engine and is, therefore, a component of great importance.

The principles of operation of the engines are well known, and need only be touched on briefly here. Thrust is produced by the rearward ejection of a jet of high velocity. The rocket's efflux consists of gases from the combustion of propellents supplied from the vehicle's tanks; the ramjet's efflux consists of the products of combustion of the entrained air and the injected fuel, the latter being usually petrol or kerosene.

In the same way that the exhaust jet produces thrust, the entrained air produces a drag on the engine. The resultant thrust arises from the difference between the exhaust thrust and the inlet drag. Some drag is further produced by the engine's external surfaces.

An advantage of the ramjet appears in its low specific fuel consumption. This is about six times better than that for the rocket, in the speed range where the ramjet is operational. On the other hand, the rocket scores in that it produces a high thrust for its mass. On this basis, the rocket is about four times as good as the ramjet, at low altitudes where the ramjet is most favoured. At higher altitudes the comparison goes even more seriously against the ramjet.

Where, then, may the ramjet be used to advantage? It is helpful to take a few simple examples to illustrate the factors involved.

Present-day ramjets appear to operate at about Mach 3. Fig. 2 shows how, for steady flight at this speed, the engine plus propellent mass affects the choice of powerplant (Ref. 2). At low altitudes the ramjet comes out on top, as the effect of fuel economy is rapidly apparent. At high altitudes, however, the lower mass of the rocket engine has a strong influence, and the ramjet vehicle does not show up well at the lower durations of flight.

It is not possible to draw a complete comparison from this picture, but certain conclusions do emerge:—

(1) The ramjet compares well with the rocket for sustained flight at low altitudes. (2) The longer the duration of powered flight, the more the advantage lies with the ramjet.

We must now face some facts which operate to the ramjet's disadvantage. The engine has to be boosted from rest up to a minimum operational speed, as it will not produce thrust from rest. It is subject to high-speed limitations from the materials viewpoint, as high forward speeds result in high air temperatures in the regions where the air is slowed down to rest—for example, in the boundary-layers of the flow over the engine's internal and external surfaces.

In the process of speed variation from minimum to maximum, the air flow and shock patterns in the engine, and particularly in the intake, may undergo marked variation, and the engine must cope with this. And there are other difficulties at the very high speed end of the range, involving dissociation

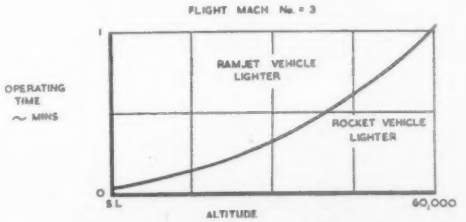


Fig. 2. Break-even times at which engine plus propellent mass is the same for ramjet and rocket vehicles.

and ionization of the air and the problem of heat release in air that has to some extent experienced such processes.

In the spirit of initial caution, an attempt was made to assess the ramjet as a possible powerplant for the second stage of a four-stage vehicle for launching an Earth satellite (Ref. 2). A solid-propellent rocket stage is followed by a ramjet stage, and the final two stages have liquid propellent rockets. The relative stage masses are compared with the mass of a three-stage liquid-propellent rocket for launching the same payload in Fig. 3.

The odds appear to be all in favour of the conventional rocket system, but assumptions used in the study must be considered in interpreting the results. The ramjet was assumed to separate from its rocket booster at Mach 2 and then follow a trajectory that maintained the thrust level as the speed was increased to the permitted maximum of Mach 5. The calculations showed that the ramjet would have appeared in a more favourable light had it been possible to provide for separation from the boosters at a lower speed, and also for operation up to a higher maximum speed.

In other words, there is a need to increase the operating speed range of the ramjet engine before it can become competitive with the rocket. The scope for improvement in this connection is evident when it is appreciated that Mach 5 is about 1 mile per second, and satellite speeds are about 5 miles per second.

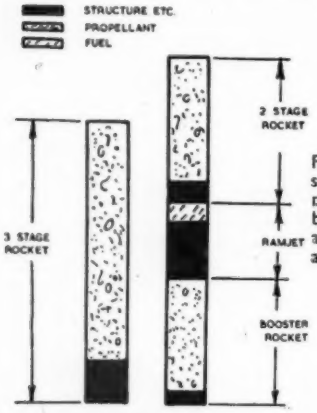


Fig. 3. Weights of three-stage rocket and vehicle comprising first-stage rocket booster, second-stage ramjet and two-stage rocket to place a given payload in satellite orbit.

Air-launched Ramjets

There are some aspects of launching by air-breathing engine systems that deserve attention, and one of the interesting studies on these lines has been that of Prof. Sandorff (Ref. 3). He considered the possibility of launching a two-stage satellite rocket from a gas-turbine-powered aircraft, and compared the result, on a basis of vehicle mass, with that for a three-stage rocket of conventional design.

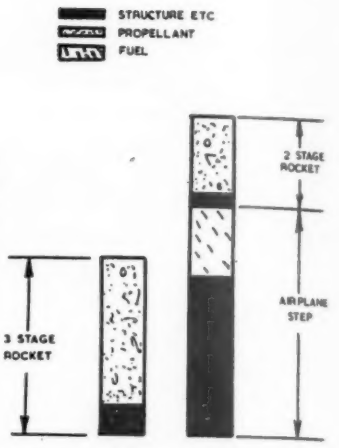


Fig. 4. Weights of three-stage rocket and vehicle comprising aircraft and two-stage rocket to place a given payload in satellite orbit (Sandorff).

The results are presented in Fig. 4. Again the conventional rocket vehicle appears in a favourable light on the score of total mass. But it will be appreciated that the aeroplane first step uses conventional and cheaper fuels, is safe to operate, and is recoverable. The rocket stages are smaller and probably simpler to develop than the first stage of the three-stage rocket.

Sandorff envisaged the use of ramjets to increase the contribution made by the aircraft step. In this connection the more recent proposals of Bristol Siddeley Engines for a combined turbojet-ramjet aircraft are of interest (Fig. 5).

What of the higher speeds required from the ramjet? It is not strictly sufficient to talk of Mach No. at the upper limits envisaged, as the composition changes in the air as it is slowed down affect the results in ways still being investigated and in many respects not fully understood. However, satellite speeds would be equivalent to about Mach 25 in the stratosphere, and that may be taken as indicating the order of things if nothing else. One would like to have an engine that operated effectively all the way up to such speeds, from some low initial speed that might be just supersonic.

Some of the problems presented by this challenge are known to be under investigation by the NASA and industry in the United States, and in this country the matter has been discussed by Dr. Jamison of Bristol Siddeley Engines in a paper reported in Ref. 4. One of the configurations considered is reproduced in Fig. 6. The unit is clearly a compromise between the requirements of low mass, flexibility, performance, and structural strength.

Unknown factors involved in a combustion and fuel injection system for operation in a supersonic air stream are reflected in the suggestion in the diagram of two possible alternative systems. Considerable research and development work will be necessary before such configurations are capable of being properly assessed.

A further proposal on rather similar lines has been made in

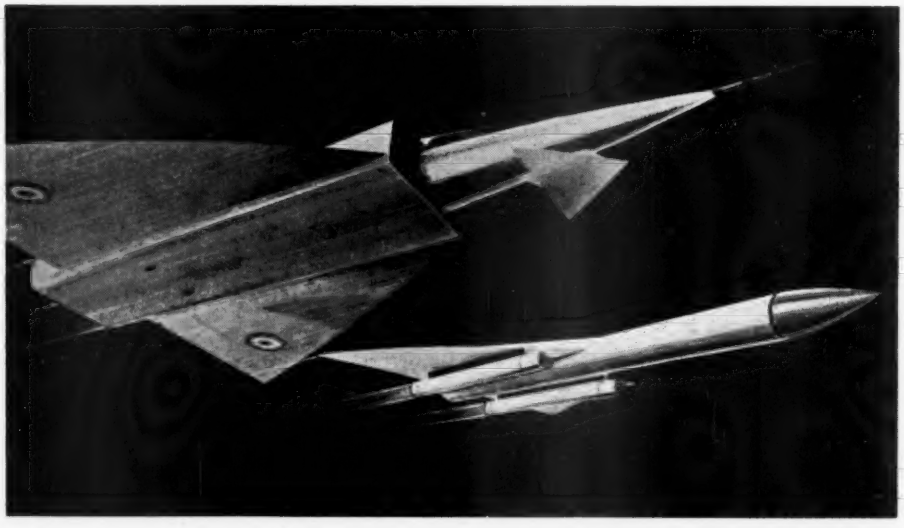


Fig. 5. Ramjet vehicle being launched from a supersonic aircraft powered by combined turbojet/ramjet engine system (Bristol Siddeley Engines, Ltd.).

a paper by Dr. W. F. Hilton, a short version of which is given in Ref. 5. This is an interesting paper, but tends to present a rather simplified picture of the aerodynamics involved, and in the author's opinion does not deal adequately with the influence of the different factors entering into the selection of suitable engineering configurations. The engine is shown in diagrammatic form in Fig. 7.

A feature of this engine is that the compression and expansion processes take place internally. This confronts the designer with severe heat transfer problems on the internal surfaces. Internal compression intakes are open to criticism on the grounds of their sensitivity to disturbances in the flow that may result in expulsion of a normal shock ahead of the intake, a condition that could be disastrous at high Mach numbers.

Before leaving our own atmosphere, it is interesting to note that from time to time proposals are made for ramjets of low thrust-mass ratio to operate on the ejection of dissociated molecules entrained in the upper atmosphere and recombined in the engine before ejection. None of these proposals yet shows sufficient practical promise.

The atmospheres of other planets offer some intriguing possibilities for ramjet propulsion. It is still unfortunately true that we know all too little about the composition of these atmospheres (finding out is one of the reasons for wanting to go there) and it is at present necessary to rely largely on speculation.

Some of the atmospheres may contain suitable gas for combustion purposes. The Giants, for example, are thought to have atmospheres consisting largely of hydrogen. An engine with a combustion system would therefore carry an injection system for oxygen or an oxidant (or some other propellent suitable for combustion with hydrogen). Unfortunately the ratio of injected oxygen to the flow of atmospheric hydrogen would be relatively high, and the specific fuel consumption would not be as good as for Earth-based ramjets. Nevertheless this is an interesting field for study, and Mr. D. S. Carton has done some sums on it (Ref. 2).

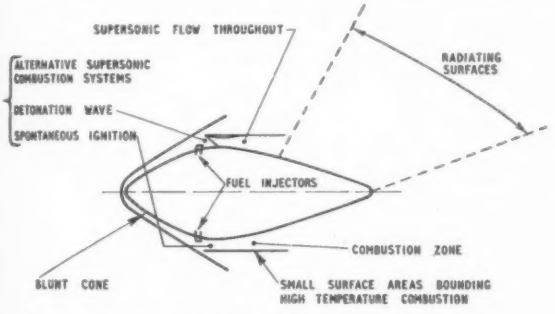


Fig. 6. Concept of a hypersonic ramjet.

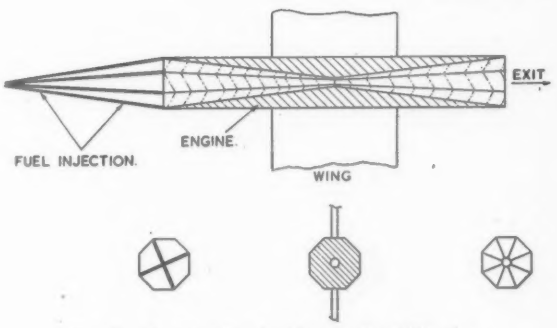


Fig. 7. Compression ignition ramjet (Hilton).

Nothing has been said about the possibilities of nuclear power for ramjets, because nothing is known except that the matter is being studied in the United States. The problem of transferring heat to the air stream at a sufficiently high temperature level is obviously a formidable one.

What then are the prospects of the ramjet? Will the remarks made in the opening paragraph of this article be justified by subsequent events? Time will sit in judgment and, as usual, will have the last word.

References

(1) "Powerplants for Missiles," THE AEROPLANE AND ASTRONAUTICS, August 28, 1959.

(2) "Atmosphere-breathing Engines in Astronautics," S. W. Greenwood and D. S. Carton, College of Aeronautics Note No. 88, October, 1958.

(3) "Some New Thoughts on Space Flight," P. E. Sandorff. Paper presented at the American Rocket Society's Semi-Annual Meeting, Boston, June, 1955.

(4) "Ramjets for Supersonic Airliners," THE AEROPLANE, December 12, 1958.

(5) "Compression-ignition Ramjet," W. F. Hilton, THE AEROPLANE AND ASTRONAUTICS, August 28, 1959.

(6) "Bristol/Ferranti Bloodhound SAM," THE AEROPLANE AND ASTRONAUTICS, September 18, 1959.

This "hammock-seat" restraint system, designed by Boeing for future space-pilots, is made of nylon net with steel cables sewn into the seams. In the revolving cabin simulator is Gary Graham, of Boeing's Aero-Space Division, who devised the system. The artist's impression shows how the space pilot would be suspended within the cabin of his vehicle. Weight-saving is claimed to be the chief advantage of this ingenious device—presumably important in paring down the mass of Dyna-Soar.

Satellite Scale Drawings

IN our correspondence columns last week, a reader, Mr. G. B. Bathurst, raised some questions concerning the Soviet space vehicles. The following comments are by our astronautical correspondent:—

It is doubtful if Sputnik II and Sputnik III were launched by the same rocket system, or at least by the same arrangement of staging. What can be said with more certainty is that the same booster was used for Sputnik III and Lunik I, although the latter almost certainly had a specially developed top stage.

The final stage of Lunik I was shown in the form of a full-sized model approx. 20 ft. long by 10 ft. diameter at the Soviet Exhibition of Science, Technology and Culture in New York this summer. The "pin at the centre of Lunik's base" is presumably a dummy representation of the rocket nozzle; the eight hold-down clamps used to lock the final stage to the previous stage seem quite adequate for their job.

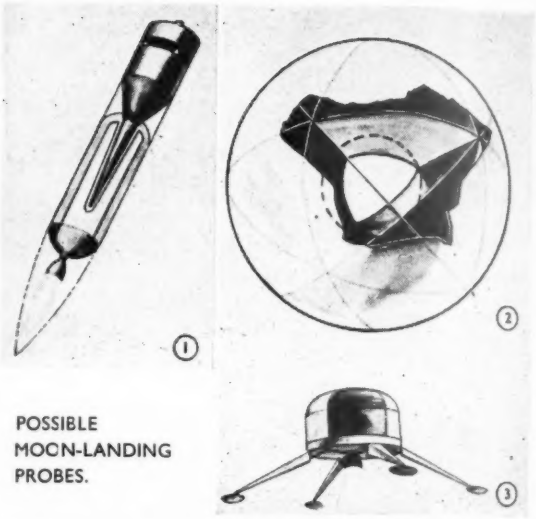
Two junction boxes at the base, joining external conduit down the sides of the rocket, undoubtedly provide interconnection with lower stages for guidance and control equipment mounted in the top stage. Scale drawings of Sputniks II and III, and Lunik I final stage, illustrating these features, were published in THE AEROPLANE AND ASTRONAUTICS, October 9, 1959, p. 318. Photographs of the Lunik top stage appeared in our issues of August 28 (p. 65); September 18 (p. 208) and September 25 (p. 265).

Moon Seismograph

THE Moon, it seems, will be visited rather frequently over the coming years, if not by man by his robot emissaries. Contracts worth nearly £6½ million have recently been placed by NASA for instruments to probe the lunar surface.

A "lunar seismograph" to be soft-landed on the Moon within five to six years will be the particular concern of Columbia University and the Californian Institute of Technology, who are to collaborate in its design and construction. This detection system, it is suggested, would provide a method of studying the make-up and crust activity of the Moon. Information of the types of rocks there, whether parts of the sub-strata are molten and details of the size, frequency and velocity of meteorites hitting the Moon, are some of the aims of the project.

Size, shape and weight of the lunar instrument package will depend both on the guidance ability of the rocket system and the payload capacity. Although it is assumed that retro-rockets will be used to soften the impact, a great deal will depend, in designing the instruments, on the actual sinking rate at touchdown, and whether the landing vehicle remains upright. The present aim is a "rugged" seismometer weighing about 10 to 20 lb. Meanwhile, other agencies are considering various vehicle configurations.



1—Impact vehicle with solid retro-rocket and penetration spike; 2—Crushable sphere with central instrument package; 3—Soft-landing vehicle, with full control.

Contracts have also been placed with the Naval Research Laboratory for instrumentation to measure the Moon's natural radioactivity, and also for lunar data acquisition and recording equipment.

The present NASA proposals are reminiscent of the Migrant probe vehicle which was the subject of a pilot design study by members of the British Interplanetary Society in 1958 (THE AEROPLANE AND ASTRONAUTICS, May 8, 1959, p. 554). Migrant, the shortened form of Moon Instrumented Guided Rocket and Notifying Transmitter, was also designed for seismic, meteorite and radioactivity studies.

Protective Coatings for Rocket Engines

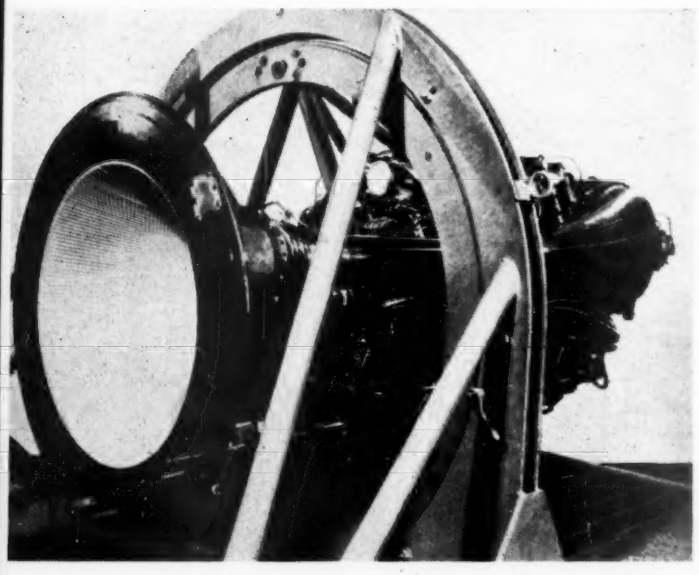
THE combustion chamber of the XLR-99 rocket engine for the X-15 research aircraft has a specially developed protective coating of zirconium oxide. This engine's thrust is more than 50,000 lb. and its theoretical combustion temperature 4,950° F. Although on each X-15 flight it will run for less than two minutes at full thrust, it is a "long-life" engine compared with missile rocket units. Developed by Reaction Motors, the XLR-99 can be throttled over a range of thrust and can also be stopped and restarted in flight.

Propellents for this engine are ammonia and liquid oxygen. The thrust chamber is regeneratively cooled by liquid ammonia which passes down the stainless steel tubes which form the walls of the chamber. Its inner surface is coated with a zirconium oxide compound known as Rokide Z. This is sprayed onto the inside of the chamber walls, using an oxy-acetylene gun. It forms a hard heat-resistant surface about 0.020 to 0.040 in. thick which protects the chamber and prolongs its life.

Rokide coatings of this type have been developed in the U.S. by the Norton Co. In Britain the patent is owned by the Norton Grinding Wheel Co., Ltd., of Welwyn Garden City, who are using the process and are granting licences for it.

Rokide Z has been developed specially for heat-resisting applications, but other oxide coatings have been produced by the Norton Co. as wear-resisting coatings and for high-temperature electrical insulation. They are suitable for a wide range of aeronautical and industrial uses.

For example, an epoxide-Rokide-epoxide sandwich has been developed jointly by Nortons and de Havilland Propellers as a protection coating for propellers. Both this and a protective lacquer loaded with Rokide powder have shown up well in abrasion tests on a full-scale rotating propeller. These treatments are about to be evaluated on a Britannia in airline service.



The inner surface of the combustion chamber for the XLR-99 rocket engine in the X-15, is coated with Rokide Z—a zirconium oxide compound—to give a hard heat-resisting surface.

Personal Flying

Flying the T.K. Turbi

by John Fricker

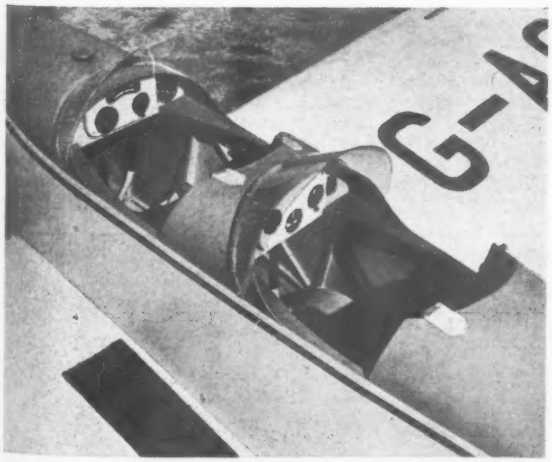
IN the midst of all the Sputniks, Mach-2¼ turbo-ramjet rocket fighters and intercontinental ballistic what-nots, it is pleasant to turn to an airborne vehicle built for no other purpose than the sheer fun of flying. Built, too, by a bunch of amateurs—if the former students of the D.H. Technical School will pardon the phrase—since their normal activities concern the aforesaid futuristic ironmongery, and are far removed from the vintage world of light aeroplanes.

The Tech. School Turbi, appropriately registered G-AOTK, followed the tradition of the pre-War series of T.K. aircraft designs in being built by D.H. students—in this case taking something like three years of their spare time. The well-known French two-seater design by the late Roger Druine was selected on the basis of its approval by the Popular Flying Association for amateur construction, and the consequent availability of plans and so on. The first longeron was ceremonially "laid" by the President of the P.F.A., Mr. Peter Masefield, at Hatfield Technical College, in April, 1955, and the Turbi made its initial flight, in the hands of D.H. test pilot Pat Fillingham, on August 9, 1958.

Since then, in its first year of operation by the nine members of the T.K. group, the Turbi has flown more than 100 hours, much of this on long touring flights, for an all-in cost of about 15s. an hour. A number of flights have been made to the Continent, and, as an example of the economy of the Turbi, the return fare to Paris, for the two occupants to visit the Aero Show, amounted to about £2 10s. per head.

The airframe of the Turbi closely follows the wooden and fabric construction of the smaller single-seat Turbulent from which it was derived. Some flight impressions of the Turbulent appeared in our issue of April 27, 1956.

G-AOTK showed a very high standard of workmanship on inspection at Hatfield, with an equally good finish both inside and out. Slightly unconventional cowling lines were a reminder of the installation of a 62-b.h.p. Walter Mikron II instead of the 45-b.h.p. Beaussier 4 BO2 inverted four-cylinder engine, adapted from a Citroen automobile unit, for which Turbi was designed.



Photographs copyright "The Aeroplane and Astronautics"

Despite its ultra-light status, the Druine Turbi offers a reasonable amount of room and comfort in its tandem cockpits, which have full dual control.

Although substantially more powerful than the original powerplant, the Mikron is considerably lighter. To maintain the weight and balance schedule it was found necessary to carry about 30 lb. of ballast in the engine bay after the initial test flights, alteration of tailplane incidence to reduce the tail-heavy tendency having proved ineffective. G-AOTK is still within the original ultra-light weight limit, however, and has the benefit of a useful power margin.

Although this article is primarily about the T.K. Turbi, I also flew on several occasions G-APFA the other British-registered aircraft of this type, which, as its registration suggests, belongs to the Popular Flying Association. It differs from 'TK in having a 65-b.h.p. Continental flat-four engine (having originally flown with a Coventry Victor Neptune), and a coupé canopy with two portions opening sideways over the tandem cockpits.

These modifications result in a very different outlook, over the broad flat nose with its sharply tapered cowling, from the roomy "glasshouse." The flying characteristics, however, remain just as pleasant, if not more so, and the performance seems largely unchanged. The extra drag of the wide engine cowling appears to balance the increased power and faired cockpits.

For solo flying, the Turbi is controlled either from the front cockpit, which is furnished in the simplest manner with basic instruments and controls, or can be flown from the rear when suitably ballasted. The single rev-counter in 'TK can be seen over the shoulder of the front occupant from the rear seat, which also has basic flight instruments plus a turn-and-bank, and, for want of room elsewhere, the sole oil pressure gauge.

Both cockpits have interlinked throttle boxes on the port side, with power, trim and fuel cock controlled by adjacent knobs sliding in longitudinal slots. It was originally possible, when flying with two persons on board, which necessitates using full forward trim, to select the wrong knob without visual verification, and turn the fuel off, instead of pushing the trim knob—but this has since been rectified by a simple spring catch.

With the original elevator tab, G-AOTK runs out of forward trim with two up. Although this effect gets progressively worse as fuel is used from the 14-gal. tank, with its simple float indicator, under the front coaming, the forces involved are very small. A longer tab is to be fitted to rectify the situation.

Although slightly narrow, both cockpits, with their glider-type seats, are comfortable and afford an excellent view. From the rear, this has been improved by raising the seat, which was also moved forward for C.G. reasons, exposing the occupant slightly more to the slipstream, but the deep windscreen on the front cockpit obviates the use of goggles. I found the rudder pedals there rather far apart, with lots of space in between, and nothing to prevent leather-soled shoes from slipping off the flat wooden controls.

After a classic hand-swing start, the Mikron idles with characteristic sweetness, although its response over the initial range of throttle travel is slightly sensitive. With no brakes and a fixed tailskid, taxi-ing involves a return to basic

principles, but, except on very hard surfaces, the amount of power needed to keep moving results in adequate control.

With either one or two people on board, there appeared to be no tendency for the tail to come up during taxi-ing and general ground stability was good. Brakes and a tailwheel can be fitted if required.

In the air, the fingertip sensitivity of control, with minute stick forces, is clearly allied to the Turbulent, but there was a noticeable and very welcome increase in stability, which was never a strong point of the smaller machine. This was particularly apparent directionally, where a dorsal fin extension has been introduced.

Because of the large control surface areas, very little stick displacement is needed for each change in attitude. The elevator appeared particularly, but not excessively, sensitive—with the ailerons very slightly heavier, and the rudder just about right. Control harmonization, in fact, is excellent, at all speeds, so that the Turbi is very pleasant to fly. Elevator stick forces appeared to vary from about 4-6 lb. per *g*, while the rate of roll at cruising speed was about 40-50°/sec.

On take-off, which had been through long grass alongside the Hatfield runway, the rudder had become effective almost immediately, although there was little or no tendency to swing. The Turbi unstuck at about 40 m.p.h. after a run of a couple of hundred yards, and with the airscrew then fitted, it was necessary to throttle back slightly to keep the revs. down to the approved maximum continuous rating of 2,500 r.p.m. Best climbing speed was 55 m.p.h. and, with two up, the rate of climb appeared to be about 550 ft./min., which is quite reasonable for an ultra-light.

Throttled back to 2,400 r.p.m., G-AOTK settled down to just under 80 m.p.h., at which the Mikron uses only about 2.8 g.p.h., but with a new wooden airscrew it now cruises at 85. The Turbi, therefore, has a safe endurance of about four hours, which is useful for touring, although baggage space, behind the rear seat, is rather limited.

At slow speeds the Turbi retains its docility, and lateral control remains, with the aid of the fixed letter-box slots, down to the stall. The breakaway comes with little or no warning at about 30-35 m.p.h., power off, with the stick half-way back and the nose falls quite straight with very little loss of height. Power on, the stall is equally abrupt at less than 30 m.p.h. I.A.S. with full aft stick, but if this is maintained it is possible to hold a nose-high attitude at stalling speed with a brisk rate of descent.

The Turbi has no flaps but, with two up, a trimmed approach speed of 55 m.p.h. gave a pleasantly steep glide path, power off and a brief float before landing. Gentle sideslips are also possible to vary the approach path, the limiting factor being the amount of top rudder available. The elevators remain very sensitive for the round-out, which requires little aft stick movement, and it is easy to touch-down tail-skid first if the aircraft is not checked in the three-point position.

Touch-down attitude is not critical, however, and the Turbi shows little inclination to bounce. If the speed is allowed to fall below about 50 m.p.h. with two up, the rate of sink becomes quite high and there is virtually no float before touch-down. The conventional handling qualities of the Turbi make it quite suitable in fact, for *ab initio* training, although this is not yet being done by the T.K. Group.

For the expenditure of about £430, including the engine, plus a formidable number of man-hours, the members of the Hatfield group have a first-class sporting aeroplane with extraordinarily low operating costs. Although Walter Mikron engines are now few and far between in this country, anyone with the necessary patience can build a similar Turbi for equally economical flying, or alternatively the design may be fitted with any other engine of 45-65 b.h.p.

Technical Data

DIMENSIONS.—Span, 28 ft. 6 in.; length, 22 ft. 6 in.; wing area, 145.2 sq. ft.

WEIGHTS.—Empty, 684 lb.; fuel, 90 lb.; oil, 18 lb.; crew, 330 lb.; max. gross, 1,200 lb.

PERFORMANCE.—Max. speed, 100 m.p.h.; cruising speed, 85 m.p.h.; initial climb, 550 ft./min.; range, 320 miles; take-off run, 600 ft.; landing run, 414 ft.

Personal Flying Notes

The link between motor racing and sporting flying which has existed since the memorable days of Brooklands was further strengthened last week when a pewter tankard belonging to the late Mike Hawthorn was handed over to the Royal Aero Club by the Steering Wheel Club. It is to be presented annually to the pilot who demonstrates most convincingly by his flying, the utility of light aircraft for business and executive use, in addition to private purposes.

As well as being the first British motor racing champion of the World, Mike Hawthorn was a keen private pilot, and frequently used his aircraft for commuting between race meetings.

"Mike's Mug" was handed over to Col. C. F. H. Gough, chairman of the Royal Aero Club, on October 19, which was the first anniversary of the Moroccan Grand Prix that gained Hawthorn his championship. The presentation was made on behalf of the Steering Wheel Club by the well-known Australian racing driver Jack Brabham who is at present leading in points for the next World Championship.

• • •

A motoring organization with a long record of aviation interest is the Automobile Association, which is introducing a new application for its D.H. Rapide next month, with the opening of the London-Birmingham motorway. This is to be regularly patrolled from the air whenever weather conditions permit, to provide a continuous breakdown service, until a complete assessment of service requirements on the motorway has been formed. This will take at least two weeks, and perhaps even longer.

The Rapide will fly at about 1,000 ft. on its patrols, and will be in constant radio contact with an A.A. super-mobile office at Broughton flyover, near Newport Pagnell. It will also be in touch with the fleet of specially equipped A.A. motorway patrol vehicles which will be on duty every day from 08.00 hr. to 20.00 hr. Throughout the night, A.A. Land-Rover breakdown vehicles will operate a radio stand-by service.

Chief pilot of the A.A. aviation service is Mr. D. Whitehead, assisted by Mr. W. Lewis. The A.A. Rapide is based at Fair Oaks.

• • •

Since September, 1958, when production of the Edgar Percival E.P.9 was taken over by the Lancashire Aircraft Company at Squires Gate, its powerplant has been standardized as the 295 b.h.p. Lycoming GO-480-G1A6 driving a three-bladed Hartzell airscrew, in place of the former 270 b.h.p. Lycoming and two-bladed propeller.

Despite this change the price of the Prospector, as the E.P.9 is now called, has remained unchanged since April, 1957, at £9,360 for the aircraft in standard form, equipped for cargo-carrying. Fitting the Prospector out as a six-seater, with a lined and sound-proofed cabin, costs a further £450, while complete spraying equipment, including a 170-gal. chemical tank, for agricultural operations, adds £850 to the basic price.

For dusting, a 33-cu.-ft. hooper, the necessary distributor and operating controls costs £415, or the combined equipment may be had for £1,090.

Other optional extras include full flight instruments (£340), navigation and landing lights (£65), 11-channel Ekco VHF (£250), and dual control (£80).

With its increased power, the Prospector has a maximum level speed of 146 m.p.h., a cruising speed of 128 m.p.h., an initial climb of 960 ft./min., and a service ceiling of 12,500 ft. The take-off distance to 50 ft. at the gross weight in standard form of 3,700 lb., is 1,065 ft., while the landing distance from a similar height is 1,005 ft. Stalling speed, with flap, is 35 m.p.h., and the normal range, 580 miles. Empty weight is 2,072 lb., and the agricultural overload weight 4,320 lb.

PROSPECTIVE SPRAYER. — Now produced as standard with a 295 b.h.p Lycoming engine and a three-bladed airscrew, the Lancashire Aircraft Prospector is suitable for crop-spraying or -dusting in addition to passenger or freight transport, and has an excellent short-field performance.

Gliding Notes

by Dr. A. E. Slater

ALTHOUGH a barograph trace provides the most revealing record of a soaring flight, nearly all barograph pens move round the arc of a circle, so that it is difficult to compare at a glance the various rates of climb and sink during the flight. Now an instrument has been produced incorporating a linkage which moves the pen almost vertically up and down, and which also damps out oscillations of the pen, even under 4*g* accelerations.

Actually, the standard instrument, instead of a pen, has a stylus which scratches smoked paper, but you can have a pen if you like. The standard range is up to 20,000 ft., but 50,000 ft. can be arranged. The instrument, which is remarkably small for the height of the trace it makes, is marketed by Slingsby but is made by Firth Cleveland Instruments, of Treforest, in Glamorganshire.

Newsletters from Slingsby Sailplanes are no longer sent to the Press—not even to *Sailplane and Gliding*. But the latest one, scrounged from the nearest gliding club, is found to give a list of the number of sales since 1942 of 12 different types which have gone into production. The total number is 1,148, and the Cadet heads the list with 394.

The reason is that the Air Training Corps started using them for elementary solo training, although the Cadet was designed solely for pupils attempting their first soaring flights. It came out first in 1936 as a replacement for Lippisch's Prüfling of 1926, the first machine to enable *ab initio* pupils to reach the soaring stage.

Next come the Sedbergh, or T-21b, with 223 produced, and the Tandem Tutor, or T-31, with 181. In addition to the use of the Sedbergh for dual training in the A.T.C., both these two-seaters have had large sales abroad, and a pair of T-31s has just been ordered by the Club de Planeadores de Concepcion in Chile; the first is in kit form, and the second will be complete. Are we at last getting nearer the day when someone will soar along the Andes from end to end among the condors?

Another foreign order is by the Russian Trade Delegation in London for a Skylark 3B, and they are also reported to have ordered an Olympia 419.

* * *

CAMBRIDGE University Gliding Club reckons its activities by academic years, not calendar years; so the first cross-country of the new year was 58 miles to Daventry by the president, John Pringle, off a winch launch on October 4. Last year "(i.e. the year ending September 30 this year) was easily the best in the club's quarter-century of history: flying hours, 1,040, reached four figures for the first time, and 5,642 launches were also a club record. But cross-country mileage, 2,171, was 200 less than in 1956/7, and this is attributed in the latest newsletter to lack of alertness in taking advantage of this summer's exceptional weather.

Another club record for the year was 55 flights of over 2 hours in thermal lift, and 11 of these exceeded 5 hours. In this connection it is worth recording that in 1937, when a government subsidy was given only to gliding clubs with "soaring sites," the Cambridge Club got a share of the subsidy by demonstrating that a soaring site doesn't have to include a hill; the club's first cross-country flights were made from winch launches into thermals at 800 ft. over a flat field at Caxton Gibbett, and by this means Kenneth Lingford went 7 miles to St. Neots and Keith Turner 10 miles to Rampton, both in the Cambridge 1.

Siegfrid Neumann has finished the academic year at the top of the "president's ladder" with 3,102 points: from this eminence he looks down upon the runners-up, Peter Neilson with 985 points and Lionel Alexander with 844. Everyone on the ladder must now descend half-way to the bottom before starting next year's climb towards the president's trophy.

Gil Philips, the club's chief engineer and an instructor for many years past, is returning to his native South Wales, where he has already begun organizing a gliding club for Pembrokeshire. The attempt of another group to form a club in the same county with a pair of second-hand Cadets, which I mentioned in these Notes a couple of years ago, has disintegrated; and so, I believe, have the Cadets.

In North Wales Mr. Malcolm Williamson, of Runcorn, is trying to form a gliding club to operate on the Clwyd Hills, where W. E. "Bill" Crease's Clwyd Gate Café has been a base for visiting gliding expeditions for over 10 years.

Groundabout

Aviation Intelligence. K.L.M. have really been living it up lately—40th Birthday celebrations, new aircraft markings, revival of "Contact," their monthly newspaper, and now, the master move, the technical triumph: "POLAR COCKTAIL SECRET REVEALED." Served on their Polar flights, the stimulant contains vodka, Drambuie and Campari and its colour, they say, bears a remarkable resemblance to that of the Arctic sky at dawn. After you've had the drink, that is.

*

Facing West. When I come across a really noble profile, I like to get at it, especially when the owner is a keen aerophile. Bill West rates. President of West Instrument Corpn., Chicago, with a factory here in Brighton, he was a war-time flying instructor, flew Thunderjets in the Illinois Air National Guard and now thrashes around in his Bonanza. And just dig that profile.

HOW WEST TEMPERATURE CONTROLS WERE INSPIRED

A to Z. Any big-headed tendencies which I may be developing are regularly subdued by the arrival of the monthly newsletter of I.S.A.W. (the International Society of Aviation Writers). It is addressed to "Mr. Chris Wren, Zeronautical Cartoonist."

*

Point Taken. At an electrical show in Paris, visitors were intrigued by a missile called Veronique. What, they wondered, was that ball on its tip? A secret homing device? Or warhead? Nothing of the kind—just a safeguard against visitors injuring themselves on the missile's sharp point. Splendid; heaven forbid that these things should hurt anybody.

*

PRO and CON—5. More dictionary definitions of P.R.O.-manship:—

PROmpt: Ready and quick to act as occasion demands; to assist a speaker who is at a loss for the next word—("Three millions, Sir Maximilian—and it was a *loss*, not a profit . . .").

PROmptuary: A store-house, a repository—("Yes, 1932, with two Jupiters—oh, about 160 m.p.h.—no, just the prototype—not at all, that's what I'm here for—good-bye—Heavens, what do they think I am—a promptuary?").

PROp: A support; a stay sustaining a superincumbent weight—("And yet we're the first department to get the chop . . .").

PROpagandist: One devoted to the spreading of any system of principles—("Well, not *any* system . . .").

by Wren

NOTES AND EVENTS

SURVIVAL.—Manufactured by Beaufort (Air-Sea) Equipment Ltd., this Type V Liferaft is to be used by Qantas and other airlines. The danger of inverted inflation is eliminated, as the raft is fully reversible. It seats 26 people and the canopy is erected automatically when required.

SCANNING UNIT.—Research and Control Instruments, Ltd., announce their intention to market a new Philips Scanning Unit (PW.4083). Working in conjunction with other units, the instrument is designed to sweep the energy spectrum at various speeds. Offering a choice of four different speeds, the unit contains a helical potentiometer driven by a synchronous motor. The potentiometer may be manually operated and provision is also made for automatic stopping of the motor at the end of a scanning period.

DISTRIBUTORS. — The Elgar Machine Tool Co., Ltd., 127-178 Victoria Road, Acton, W.3, have been appointed exclusive distributors in the U.K. for the H.Y.O.P. range of jig boring machines manufactured by Apparatebau Burkhardt, Pfullingen b., Reutlingen, Germany.

UNDERCARRIAGE CONTROL.—To meet the preference for lever-action control of landing-gear selection, Dowty Nucleonics Ltd., of Brockhampton Park, Andoversford, Glos, has produced a compact two-position lever switch as a complement to its range of undercarriage push-button switches. The switch lever carries a spring-loaded cup which enters a gate in both the "up" and "down" positions and incorporates an electrically operated lock section which prevents an "up" selection being made while the lock section is de-energized.

YUGOSLAV ORDER.—In connection with the equipping of the new Surcin Airport, Belgrade, a Yugoslavian Purchasing Commission recently visited London and placed substantial orders with Redifon, Ltd., for radio equipment to be installed at this airport and other places. The contract calls for a total of 37 transmitters for beacon and communications service; automatic beacon changeover equipment; remote control apparatus for all transmitters, and general-purpose communications receivers.

FUEL TURBIDITY. — Southern Instruments, Ltd., of Camberley, United Kingdom distributors for Sigrist and Weiss, Ltd., of Zürich, have announced a new continuous flow Sigrist Photometer of interest to the aircraft industry. This new device provides continuous measurement of the concentration of suspended particles in liquids and gases. Water droplets, rust and dirt down to 0.1 p.p.m. can be measured, and the instrument provides signals for remote control and/or alarm purposes when a given level of turbidity is exceeded. An inkless recorder is also incorporated.

POWERED JACKING. — Brown Brothers (Aircraft), Ltd., of Bedford Road, Northampton, have added power operated jacks to their range of manually operated Rotheswan Aerojacks. Designed to provide gang powered jacking for maintenance work on large aircraft, these new jacks have been approved and ordered for Britannias by M.o.S. and Bristol Aircraft.

ATKINS LIGHT APPROVED.—The high-intensity, anti-collision flashing light unit developed by Captain H. W. Atkins and produced by Minneapolis-Honeywell, has been approved for airline use by the F.A.A.

Company Notices

NEW COMPANIES

Esso Transportation Co., Ltd. (638,211).—Private co. Reg. September 28. Cap. £100 in £1 shs. Objects: To carry on the business of ship and barge owners and lightermen, and as oil merchants and brokers, etc. Directors: John H. Piesse, 9 Somerville House, Manor Fields, S.W.15; Denys M. R. Piesse, 4 Wellington Court, Knightsbridge, S.W.1. Sec.: C. J. Pereira. Solrs.: Piesse and Sons, E.C.2. Reg. office: 73 Cheapside, E.C.2.

Aerial Farm Services, Ltd. (638,471).—Private co. Reg. October 1. Cap. £5,000 in £1 shs. Objects: To carry on the business of agricultural contractors, agricultural spraying and spreading contractors, etc. Directors are: Wm. A. Jordan, Holme Mills, Biggleswade, Beds, Miller and Corn Merchant (Director of Wm. Jordan and Son, Ltd., and W. Jordan and Son (Silo), Ltd.); Roy Slarke, Wood Farm, Denton, Harleston, Norfolk; Michael W. Wood, Holmewood, Biggleswade. Sec.: M. W. Wood. Solrs.: E. T. Leeds Smith and Co., Sandy, Beds. Reg. office: Holme Mills, Biggleswade, Beds.

Artricia Travel, Ltd. (638,275).—Private co. Reg. September 29. Cap. £5,000 in £1 shs. Objects: To carry on the business of travel agents, etc. Directors: Richard A. Butt, 109 Park Avenue, Enfield, director of H. Butt and Son, Ltd.; Arthur F. Lambert, 21 Dryden Road, Bush Hill Park, Enfield, director of Artricia Photographs, Ltd.; Charles A. Webb, director of H. Butt and Son, Ltd.; Brian W. Cuelter, director of Artricia Industrial Pictures, Ltd. Sec.: Richard A. Butt. Reg. office: 1 Guildhall Chambers, Basinghall Street, E.C.2.

CHANGE OF NAME

Brush Group Services, Ltd. (397,094), Dukes Court, Duke St., S.W.1.—Name changed to Hawker Siddeley Industries (Services), Ltd., on June 22, 1959.

INCREASE OF CAPITAL

Westland Aircraft, Ltd. (302,632).—Westland Works, Yeovil, Somerset. Increased by £1,000,000 in 5s. ordinary shares, beyond the reg. cap. of £4,000,000.

Aviation Calendar

October 30.—R.Ae.S. inaugural lecture, "Man-Powered Aircraft Group—Résumé of the Theory and Practice," by H. B. Irving, Dr. D. R. Wilkie, T. R. F. Nonweiler, B. S. Shenstone, at the R.Ae.S. Library, 4 Hamilton Place, **London,** W.1, at 19.00 hrs.

October 31.—R.Ae.S. Luton Branch, visit to de Havilland Engine Co. test beds at **Hatfield.**

November 2.—R.Ae.S. Boscombe Down Branch lecture, "Inertia Navigation," by J. E. Pateman, Asst. General Manager, Elliot Bros. (London), Ltd., at the Lecture Hall, A. and A.E.E., **Boscombe Down,** Wilts, at 17.30 hrs.

November 2.—R.Ae.S. Derby, Fourth Sir Henry Royce Memorial Lecture, "Power for an Airline," by B. S. Shenstone and H. G. Rossiter, at Rolls-Royce Welfare Hall, Nightingale Road, **Derby,** at 18.15 hrs.

November 2.—R.Ae.S. Henlow Branch lecture, "Black Knight," by H. G. R. Robinson, in building 62, The Technical College, **Henlow,** at 19.45 hrs.

November 3.—R.Ae.S. Luton Branch lecture, "Materials for Supersonic Aircraft," by G. Meikle, B.Sc., F.I.M., at the Napier Senior Staff Canteen, **Luton Airport,** at 18.15 hrs.

November 4.—R.Ae.S. Bristol Branch, Brains Trust with Sir George R. Edwards, Sir George Gardner, E. C. Bowyer, Peter Twiss, Peter G. Masefield, question master, Prof. A. R. Collar, at Filton House, Filton, **Bristol,** at 18.00 hrs.

November 4.—R.Ae.S. Swindon Branch lecture, "Power from Nuclear Energy," by Dr. M. D. Wood, at The College, Victoria Road, **Swindon,** at 19.30 hrs.

November 5.—University of London Extra Mural Studies lecture, "Storm Clouds," by Dr. R. S. Scorer, M.A., Ph.D., at The Kronfeld Club, 74 Basement, Eccleston Square, **London,** S.W.1.

November 6.—Helic. Assn. of G.B. lecture, "The Application of the Jet Flap to Helicopter Rotor Control," by R. Dorand (Giravions Dorand), at the Library, The Royal Aeronautical Society, 4 Hamilton Place, **London,** W.1, at 18.00 hrs.

November 6.—R.Ae.S. Brough Branch Annual Dinner and Dance, at Jackson's Ballroom, **Hull.**

November 9.—Institute of Transport lectures, "Fares Structures": "Air," by J. L. Grunebridge, O.B.E., M.Inst.T.; "Rail," by A. W. Tait, M.Inst.T.; "Road," by A. F. R. Calling, M.Inst.T., at Jarvis Hall, 66 Portland Place, **London,** W.1, at 17.45 hrs.

November 11.—R.Ae.S. Graduates' and Students' Section lecture "The Flight Testing of Rotorcraft," by Sqn. Ldr. W. R. Gellatly, at the Library, 4 Hamilton Place, **London,** W.1, at 19.30 hrs.

November 11.—R.Ae.S. Brough Branch, 6th Cayley Memorial Lecture, "The Work of the R.A.E. Bedford," by Sir George Gardner, at the Writing Room, Royal Station Hotel, **Hull,** at 19.00 hrs.

November 11.—R.Ae.S. Bristol Branch, film show, at Filton House, Filton, **Bristol,** at 18.00 hrs.

November 11.—R.Ae.S. Chester Branch lecture, "Automobile Aerodynamics," by F. A. Costin, at the Lecture Theatre, Grosvenor Museum, **Chester,** at 19.30 hrs.

Personal Notices

BIRTHS

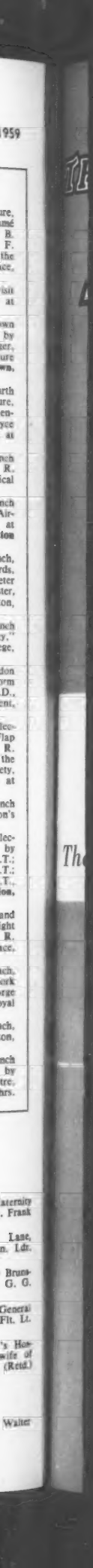
Appleyard.—On October 19, at Eskdale Maternity Home, to Pamela (*née* Hirst), wife of Flt. Lt. Frank Appleyard, R.A.F.—a daughter.

Dean.—On October 16 at 23 Pedley Lane, Clifton, Bedfordshire, to Joan, wife of Sqn. Ldr. H. M. Dean, R.A.F.—a daughter.

Farley.—On October 2, at Chatham, New Brunswick, Canada, to Tina, wife of Sqn. Ldr. G. G. Farley, R.A.F.—a daughter.

Jackson.—On October 16, at Edgware General Hospital, to Ann (*née* Thompson), wife of Flt. Lt. D. L. Jackson, R.A.F.—a son.

Simpson.—On October 20, at St. David's Hospital, Bangor, to Janette (*née* Fowles), wife of Group Capt. N. F. Simpson, O.B.E., R.A.F. (Retd.)—a daughter.

DEATH

Ash.—On October 20, Wing Commander Walter Noel Ash.